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LAMPIRAN

Lampiran 1. Data Pengukuran Jumlah Nilai Muatan Berkas Elektron

1.1 Muatan pada energi 6 MeV dengan kedalaman Referensi (Z_{ref}) 1,41 cm

No	Luas Lapangan (cm^2)	Volt (V)	P (Kpa)	T ($°C$)	RH (%)	M (nC)/100 MU
1	6 x 6 cm^2	+300	101.3	20,9	58	12.30
						12.38
						12.40
		Rata-rata				12.36
		-300	101.3	20,9	58	12.28
						12.39
						12.30
		Rata-rata				12.32
		+100	101.3	20,9	58	12.28
						12.28
						12.38
		Rata-rata				12.31
2	10 x 10 cm^2	+300	101.3	20.6	58	12.47
						12.48
						12.48
		Rata-rata				12.47
		-300	101.3	20.6	58	12.44
						12.46
						12.47
		Rata-rata				12.46
		+100	101.3	20.6	58	12.34
						12.35
						12.37
		Rata-rata				12.35
3	15 x 15 cm^2	+300	101.3	20.6	56	12.19
						12.22
						12.23
		Rata-rata				12.21
		-300	101.3	20.6	56	12.20
						12.20
						12.21
		Rata-rata				12.20
		+100	101.3	20.6	56	12.04
						12.05
						12.06

		Rata-rata				12.05
4	20 x 20 cm^2	+300	101.3	20.4	54	12.11
						12.12
						12.11
		Rata-rata				12.11
		-300	101.3	20.4	54	12.07
						12.10
						12.09
		Rata-rata				12.09
		+100	101.3	20.4	54	11.96
						11.95
						11.95
		Rata-rata				11.95
5	25 x 25 cm^2	+300	101.3	20.8	52	12.07
						12.09
						12.10
		Rata-rata				12.09
		-300	101.3	20.8	52	12.08
						12.07
						12.07
		Rata-rata				12.07
		+100	101.3	20.8	52	11.94
						11.94
						11.93
		Rata-rata				11.94

1.2 Muatan pada energi 9 MeV dengan kedalaman Referensi (Z_{ref}) 2,05 cm

No	Luas Lapangan (cm^2)	Volt (V)	P (Kpa)	T ($°C$)	RH (%)	M (nC)/100 MU
1	6 x 6 cm^2	+300	101.3	20,5	58	12.28
						12.29
						12.28
		Rata-rata				12.28
		-300	101.3	20,5	58	12.26
						12.26
						12.27
		Rata-rata				12.26
		+100	101.3	20,5	58	10.42
						12.14
						12.13
		Rata-rata				11.56

2	10 x 10 cm^2	+300	101.3	20.6	58	12.60
						12.62
						12.63
		Rata-rata				12.62
		-300	101.3	20.6	58	12.63
						12.62
						12.61
		Rata-rata				12.62
		+100	101.3	20.6	58	12.46
						12.47
						12.45
		Rata-rata				12.46
3	15 x 15 cm^2	+300	101.3	20.8	56	12.58
						12.59
						12.59
		Rata-rata				12.59
		-300	101.3	20.8	56	12.55
						12.56
						12.57
		Rata-rata				12.56
		+100	101.3	20.8	56	12.42
						12.42
						12.43
		Rata-rata				12.42
4	20 x 20 cm^2	+300	101.3	20.7	54	12.73
						12.75
						12.74
		Rata-rata				12.74
		-300	101.3	20.7	54	12.76
						12.75
						12.76
		Rata-rata				12.76
		+100	101.3	20.7	54	12.57
						12.59
						12.60
		Rata-rata				12.59
5	25 x 25 cm^2	+300	101.3	20.5	52	12.19
						12.20
						12.21
		Rata-rata				12.20
		-300	101.3	20.5	52	12.16

						12.18
						12.18
		Rata-rata				12.17
		+100	101.3	20.5	52	12.04
						12.04
						12.05
		Rata-rata				12.04

1.3 Muatan pada energi 12 MeV dengan kedalaman Referensi (Z_{ref}) 2, 91 cm

No	Luas Lapangan (cm^2)	Volt (V)	P (Kpa)	T ($°C$)	RH (%)	M (nC)/100 MU
1	6 x 6 cm^2	+300	101.3	20,5	58	12.38
						12.38
						12.40
		Rata-rata				12.38
		-300	101.3	20,5	58	12.35
						12.35
						12.32
		Rata-rata				12.34
		+100	101.3	20,5	58	12.24
						12.27
						12.28
		Rata-rata				12.26
2	10 x 10 cm^2	+300	101.3	20.8	58	12.85
						12.87
						12.88
		Rata-rata				12.87
		-300	101.3	20.8	58	12.82
						12.85
						12.84
		Rata-rata				12.84
		+100	101.3	20.8	58	12.69
						12.69
						12.70
		Rata-rata				12.69
3	15 x 15 cm^2	+300	101.3	20.3	56	12.73
						12.74
						12.74
		Rata-rata				12.74
		-300	101.3	20.3	56	12.75
						12.74

						12.76
		Rata-rata				12.75
		+100	101.3	20.3	56	12.58
						12.57
						12.57
		Rata-rata				12.57
4	20 x 20 cm^2	+300	101.3	20.3	54	12.54
						12.54
						12.55
		Rata-rata				12.54
		-300	101.3	20.3	54	12.51
						12.55
						12.54
		Rata-rata				12.53
		+100	101.3	20.3	54	12.39
						12.39
						12.39
		Rata-rata				12.39
5	25 x 25 cm^2	+300	101.3	20.6	52	12.40
						12.42
						12.43
		Rata-rata				12.45
		-300	101.3	20.6	52	12.43
						12.44
						12.47
		Rata-rata				12.45
		+100	101.3	20.6	52	12.34
						12.34
						12.35
		Rata-rata				12.35

Lampiran 2. Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi

2.1.1 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 6 MeV dengan luas lapangan (6x6) cm^2

a. Perhitungan kedalaman referensi (Z_{ref})

$Z_{ref} = 0{,}6.\ R_{50} - \ 0{,}1\ g/cm^2$

$= 0{,}6.\ 2{,}515 - \ 0{,}1\ g/cm^2$

$= 1{,}41\ g/cm^2$

b. perhitungan k_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0)}\ \frac{P_0}{P}$$

$$= \frac{(273{,}15 + 20{,}9\ °C)}{(273{,}15 + 20\ °C)}\ \frac{101{,}325\ kPa}{101{,}3\ kPa}$$

$$= \frac{294{,}05}{293{,}15}\ 1$$

$$= 1{,}003$$

c. Perhitungan K_{pol}

$$K_{pol} = \frac{\left|M_+ + M_-\right|}{2M}$$

$$= \frac{|12{,}32 + 12{,}36|}{2(12{,}28)}$$

$$= \frac{24{,}68}{24{,}56}$$

$$= 1{,}005$$

d. Perhitungan K_s

$$K_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2$$

$$= 1{,}198 + (-0{,}875)\left(\frac{12{,}36}{12{,}31}\right) + 0{,}677\left(\frac{12{,}36}{12{,}31}\right)^2$$

$$= 1{,}198 - 0{,}875\ (1{,}004) + 0{,}677\ (1{,}008)$$

$$= 1{,}198 - 0{,}878 + 0{,}683$$

$$= 1{,}003$$

e. Perhitungan M_Q

$$M_Q = M_1\ K_{TP}\ K_{elec}\ K_{pol}\ K_s$$

$$= (12{,}32)\frac{nc}{100\ MU}(1{,}003)(1)(1{,}005)(1{,}003)$$

$$= 12{,}456\ \frac{nc}{100\ MU}$$

$$= 0{,}125\ nc/MU$$

f. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q . N_{D,W,Q0}\ K_{Q,Q0}$$
$$= (0{,}125)\frac{nc}{MU}\ (84{,}28)\frac{mGy}{nC}\ (0{,}937)$$
$$= 9{,}872\ mGy/MU$$
$$= 0{,}987\ cGy/MU$$

g. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0{,}987)\frac{cGy}{MU}\ /99{,}59$$
$$= 0{,}991 cGy/MU$$

h. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (Z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{0{,}991\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= -0{,}009 \times 100\%$$
$$= 0{,}9\%$$

2.1.2 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 6 MeV dengan luas lapangan (10x10) cm^2

a. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0\ )}\ \frac{P_0}{P}$$
$$= \frac{(273{,}15 + 20{,}6\ °C)}{(273{,}15 + 20\ °C)}\ \frac{101{,}325\ kPa}{101{,}3\ kPa}$$
$$= \frac{293{,}75}{293{,}15}\ 1$$
$$= 1{,}002$$

b. Perhitungan K_{pol}

$$K_{pol} = \frac{\left|M_+ + M_-\right|}{2M}$$
$$= \frac{|12{,}46 + 12{,}47|}{2(12{,}47)}$$
$$= \frac{24{,}93}{24{,}94}$$
$$= 0{,}999$$

c. Perhitungan K_s

$$K_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2$$

$$= 1{,}198 + (-0{,}875)\left(\frac{12{,}47}{12{,}36}\right) + 0{,}677\left(\frac{12{,}47}{12{,}36}\right)^2$$
$$= 1{,}198 - 0{,}875\ (1{,}009) + 0{,}677\ (1{,}019)$$
$$= 1{,}198 - 0{,}883 + 0{,}689$$
$$= 1{,}004$$

d. Perhitungan M_Q

$$M_Q = M_1\ K_{TP}\ K_{elec}\ K_{pol}\ K_s$$
$$= (12{,}47)\frac{nc}{100\ MU}(1)(1)(0{,}999)(1{,}004)$$
$$= 12{,}507\ \frac{nc}{100\ MU}$$
$$= 0{,}125\ nc/MU$$

e. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q . N_{D,W,Q0}\ K_{Q,Q0}$$
$$= (0{,}125)\frac{nc}{MU}\ (84{,}28)\frac{mGy}{nC}\ (0{,}937)$$
$$= 9{,}872\ mGy/MU$$
$$= 0{,}987\ cGy/MU$$

f. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0{,}955)\frac{cGy}{MU}\ /99{,}93$$
$$= 0{,}987\ cGy/MU$$

g. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (Z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{0{,}987\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= -0{,}013 \times 100\%$$
$$= 1{,}3\ \%$$

2.1.3 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 6 MeV dengan luas lapangan (15x15) cm^2

a. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0\ )}\ \frac{P_0}{P}$$

$$= \frac{(273{,}15 + 20{,}6\ ^\circ C)}{(273{,}15 + 20\ ^\circ C)}\ \frac{101{,}325\ kPa}{101{,}3\ kPa}$$
$$= \frac{294{,}75}{293{,}15}\ 1$$

$= 1{,}002$

b. Perhitungan K_{pol}

$$K_{pol} = \frac{|M_+ + M_-|}{2M}$$
$$= \frac{|12{,}20 + 12{,}21|}{2(12{,}20)}$$
$$= \frac{24{,}41}{24{,}4}$$
$$= 0{,}999$$

c. Perhitungan K_s

$$K_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2$$
$$= 1{,}198 + (-0{,}875)\left(\frac{12{,}21}{12{,}05}\right) + 0{,}677\left(\frac{12{,}21}{12{,}05}\right)^2$$
$$= 1{,}198 - 0{,}875\ (1{,}013) + 0{,}677\ (1{,}027)$$
$$= 1{,}198 - 0{,}886 + 0{,}695$$
$$= 1{,}007$$

d. Perhitungan M_Q

$$M_Q = M_1\ K_{TP}\ K_{elec}\ K_{pol}\ K_s$$
$$= (12{,}20)\frac{nc}{100\ MU}(1{,}002)(1)(0{,}999)(1{,}007)$$
$$= 12{,}297\ \frac{nc}{100\ MU}$$
$$= 0{,}123\ nc/MU$$

e. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$$
$$= (0{,}123)\frac{nc}{MU}\ (84{,}28)\frac{mGy}{nC}\ (0{,}937)$$
$$= 9{,}713\ mGy/MU$$
$$= 0{,}972\ cGy/MU$$

f. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0{,}972)\frac{cGy}{MU}\ /99{,}72$$
$$= 0{,}975\ cGy/MU$$

g. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (Z_{max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{0{,}975\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$

$$= -0{,}025 \times 100\%$$
$$= 2{,}5\ \%$$

2.1.4 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 6 MeV dengan luas lapangan (20x20) cm^2

a. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0)} \frac{P_0}{P}$$
$$= \frac{(273{,}15 + 20{,}4\ °C)}{(273{,}15 + 20\ °C)} \frac{101{,}325\ kPa}{101{,}3\ kPa}$$
$$= \frac{293{,}55}{293{,}15}\ 1$$
$$= 1{,}002$$

b. Perhitungan K_{pol}

$$K_{pol} = \frac{\left|M_+ + M_-\right|}{2M}$$
$$= \frac{|12{,}09 + 12{,}11|}{2(12{,}03)}$$
$$= \frac{24{,}2}{24{,}06}$$
$$= 1{,}005$$

c. Perhitungan K_s

$$K_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2$$
$$= 1{,}198 + (-0{,}875)\left(\frac{12{,}11}{11{,}95}\right) + 0{,}677\left(\frac{12{,}11}{11{,}95}\right)^2$$
$$= 1{,}198 - 0{,}875\ (1{,}013) + 0{,}677\ (1{,}027)$$
$$= 1{,}198 - 0{,}886 + 0{,}695$$
$$= 1{,}007$$

d. Perhitungan M_Q

$$M_Q = M_1\ K_{TP}\ K_{elec}\ K_{pol}\ K_s$$
$$= (12{,}11)\frac{nc}{100\ MU}(1{,}002)(1)(1{,}005)(1{,}007)$$
$$= 12{,}281\ \frac{nc}{100\ MU}$$
$$= 0{,}123\ nc/MU$$

e. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$$
$$= (0{,}123)\frac{nc}{MU}\ (84{,}28)\frac{mGy}{nC}\ (0{,}937)$$
$$= 9{,}713\ mGy/MU$$

$$= 0{,}971\ cGy/MU$$

f. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0{,}971)\frac{cGy}{MU}\ /99{,}59$$
$$= 0{,}975\ cGy/MU$$

g. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (Z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{0{,}975\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= -0{,}025 \times 100\%$$
$$= 2{,}5\ \%$$

2.1.5 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 6 MeV dengan luas lapangan (25x25) cm^2

a. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0\ )}\ \frac{P_0}{P}$$
$$= \frac{(273{,}15 + 20{,}8\ °C)}{(273{,}15 + 20\ °C)}\ \frac{101{,}325\ kPa}{101{,}3\ kPa}$$
$$= \frac{293{,}95}{293{,}15}\ 1$$
$$= 1{,}003$$

b. Perhitungan K_{pol}

$$K_{pol} = \frac{\left|M_+ + M_-\right|}{2M}$$
$$= \frac{|12{,}07 + 12{,}09|}{2(12{,}01)}$$
$$= \frac{24{,}16}{24{,}02}$$
$$= 1{,}006$$

c. Perhitungan K_s

$$K_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2$$
$$= 1{,}198 + (-0{,}875)\left(\frac{12{,}09}{11{,}94}\right) + 0{,}677\left(\frac{12{,}09}{11{,}94}\right)^2$$
$$= 1{,}198 - 0{,}875\ (1{,}013) + 0{,}677\ (1{,}025)$$
$$= 1{,}198 - 0{,}886 + 0{,}694$$
$$= 1{,}006$$

d. Perhitungan M_Q

$$M_Q = M_1\, K_{TP}\, K_{elec}\, K_{pol}\, K_s$$
$$= (12{,}09)\frac{nc}{100\ MU}(1{,}003)(1)(1{,}006)(1{,}006)$$
$$= 12{,}272\ \frac{nc}{100\ MU}$$
$$= 0{,}122\ nc/MU$$

e. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q\, N_{D,W,Q0}\, K_{Q,Q0}$$
$$= (0{,}123)\frac{nc}{MU}\ (84{,}28)\frac{mGy}{nC}\ (0{,}937)$$
$$= 9{,}731\ mGy/MU$$
$$= 0{,}972\ cGy/MU$$

f. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0{,}972)\frac{cGy}{MU}\ /99{,}59$$
$$= 0{,}976\ cGy/MU$$

g. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (Z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{0{,}976\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= -\ 0{,}024 \times 100\%$$
$$=\ 2{,}4\ \%$$

2.2.1 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 9 MeV dengan luas lapangan (6x6) cm^2

a. Perhitungan kedalaman referensi (Z_{ref})

Z_{ref} = 0,6. R_{50} – 0,1 g/cm^2
= 0,6. 3,576 – 0,1 g/cm^2
= 2,05 g/cm^2

b. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0\ )}\ \frac{P_0}{P}$$
$$= \frac{(273{,}15 + 20{,}5\ °C)}{(273{,}15 + 20\ °C)}\ \frac{101{,}325\ kPa}{101{,}3\ kPa}$$
$$= \frac{293{,}65}{293{,}15}\ 1$$
$$= 1{,}002$$

c. Perhitungan K_{pol}

$$K_{pol} = \frac{|M_+ + M_-|}{2M}$$
$$= \frac{|12{,}26 + 12{,}28|}{2(12{,}27)}$$
$$= \frac{24{,}54}{24{,}54}$$
$$= 1$$

d. Perhitungan K_s

$$K_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2$$
$$= 1{,}198 + (-0{,}875)\left(\frac{12{,}28}{11{,}56}\right) + 0{,}677\left(\frac{12{,}28}{11{,}56}\right)^2$$
$$= 1{,}198 - 0{,}875\ (1{,}062) + 0{,}677\ (1{,}128)$$
$$= 1{,}198 - 0{,}929 + 0{,}764$$
$$= 1{,}033$$

e. Perhitungan M_Q

$$M_Q = M_1\ K_{TP}\ K_{elec}\ K_{pol}\ K_s$$
$$= (12{,}28)\frac{nc}{100\ MU}(1{,}002)(1)(1)(1{,}033)$$
$$= 12{,}698\ \frac{nc}{100\ MU}$$
$$= 0{,}127\ nc/MU$$

f. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$$
$$= (0{,}127)\frac{nc}{MU}\ (84{,}28)\frac{mGy}{nC}\ (0{,}925)$$
$$= 9{,}901\ mGy/MU$$
$$= 0,991 cGy/MU$$

g. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0{,}991)\frac{cGy}{MU}\ /99{,}87$$
$$= 0{,}992\ cGy/MU$$

h. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{0{,}992\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= -0{,}008 \times 100\%$$
$$= 0{,}8\ \%$$

2.2.2 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 9 MeV dengan luas lapangan (10x10) cm^2

a. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0)} \frac{P_0}{P}$$
$$= \frac{(273{,}15 + 20{,}6\,°C)}{(273{,}15 + 20\,°C)} \frac{101{,}325\,kPa}{101{,}3\,kPa}$$
$$= \frac{293{,}75}{293{,}15}\,1$$
$$= 1{,}002$$

b. Perhitungan K_{pol}

$$K_{pol} = \frac{|M_+ + M_-|}{2M}$$
$$= \frac{|12{,}62 + 12{,}62|}{2(12{,}62)}$$
$$= \frac{25{,}24}{25{,}24}$$
$$= 1$$

c. Perhitungan K_s

$$K_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2$$
$$= 1{,}198 + (-0{,}875)\left(\frac{12{,}62}{12{,}46}\right) + 0{,}677\left(\frac{12{,}62}{11{,}46}\right)^2$$
$$= 1{,}198 - 0{,}875\,(1{,}013) + 0{,}677\,(1{,}026)$$
$$= 1{,}198 - 0{,}886 + 0{,}695$$
$$= 1{,}007$$

d. Perhitungan M_Q

$$M_Q = M_1\,K_{TP}\,K_{elec}\,K_{pol}\,K_s$$
$$= (12{,}62)\frac{nc}{100\,MU}(1{,}002)(1)(1)(1{,}007)$$
$$= 12{,}734\,\frac{nc}{100\,MU}$$
$$= 0{,}127\,nc/MU$$

e. Perhitungan $D_{W,Q\,(zref)}$

$$D_{W,Q(zref)} = M_Q\,N_{D,W,Q0}\,K_{Q,Q0}$$
$$= (0{,}127)\frac{nc}{MU}\,(84{,}28)\frac{mGy}{nC}\,(0{,}925)$$
$$= 9{,}901\,mGy/MU$$
$$= 0{,}991 cGy/MU$$

f. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0{,}991)\frac{cGy}{MU}\ /99{,}93$$
$$= 0{,}992\ cGy/MU$$

g. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{0{,}992\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= -0{,}008 \times 100\%$$
$$= 0{,}8\ \%$$

2.2.3 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 9 MeV dengan luas lapangan (15x15) cm^2

a. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0\ )}\ \frac{P_0}{P}$$
$$= \frac{(273{,}15 + 20{,}8\ °C)}{(273{,}15 + 20\ °C)}\ \frac{101{,}325\ kPa}{101{,}3\ kPa}$$
$$= \frac{293{,}95}{293{,}15}\ 1$$
$$= 1{,}003$$

b. Perhitungan K_{pol}

$$K_{pol} = \frac{\left|M_+ + M_-\right|}{2M}$$
$$= \frac{|12{,}56 + 12{,}59|}{2(12{,}59)}$$
$$= \frac{25{,}15}{25{,}18}$$
$$= 0{,}998$$

c. Perhitungan K_s

$$K_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2$$
$$= 1{,}198 + (-0{,}875)\left(\frac{12{,}59}{12{,}42}\right) + 0{,}677\left(\frac{12{,}59}{11{,}42}\right)^2$$
$$= 1{,}198 - 0{,}875\ (1{,}014) + 0{,}677\ (1{,}027)$$
$$= 1{,}198 - 0{,}887 + 0{,}695$$
$$= 1{,}006$$

d. Perhitungan M_Q

$$M_Q = M_1\, K_{TP}\, K_{elec}\, K_{pol}\, K_s$$
$$= (12{,}59)\frac{nc}{100\ MU}(1{,}003)(1)(0{,}998)(1{,}006)$$
$$= 12{,}678\ \frac{nc}{100\ MU}$$
$$= 0{,}127\ nc/MU$$

e. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q\, N_{D,W,Q0}\, K_{Q,Q0}$$
$$= (0{,}127)\frac{nc}{MU}\ (84{,}28)\frac{mGy}{nC}\ (0{,}925)$$
$$= 9{,}901\ mGy/MU$$
$$= 0,991 cGy/MU$$

f. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0{,}991)\frac{cGy}{MU}\ /99{,}93$$
$$= 0{,}992\ cGy/MU$$

g. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (Z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{0{,}992\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= -0{,}008 \times 100\%$$
$$= 0{,}8\ \%$$

2.2.4 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 9 MeV dengan luas lapangan (20x20) cm^2

a. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0\ )}\ \frac{P_0}{P}$$
$$= \frac{(273{,}15 + 20{,}7\ °C)}{(273{,}15 + 20\ °C)}\ \frac{101{,}325\ kPa}{101{,}3\ kPa}$$
$$= \frac{293{,}85}{293{,}15}\ 1$$
$$= 1{,}003$$

b. Perhitungan K_{pol}

$$K_{pol} = \frac{\left|M_+ + M_-\right|}{2M}$$
$$= \frac{|12{,}76 + 12{,}74|}{2(12{,}76)}$$

$$= \frac{25,5}{25,52}$$
$$= 0,999$$

c. Perhitungan K_s

$$K_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2$$
$$= 1,198 + (-0,875)\left(\frac{12,74}{12,59}\right) + 0,677\left(\frac{12,74}{12,59}\right)^2$$
$$= 1,198 - 0,875\ (1,012) + 0,677\ (1,024)$$
$$= 1,198 - 0,885 + 0,693$$
$$= 1,006$$

d. Perhitungan M_Q

$$M_Q = M_1\ K_{TP}\ K_{elec}\ K_{pol}\ K_s$$
$$= (12,74)\frac{nc}{100\ MU}(1,003)(1)(0,999)(1,006)$$
$$= 12,842\ \frac{nc}{100\ MU}$$
$$= 0,128\ nc/MU$$

e. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$$
$$= (0,128)\frac{nc}{MU}\ (84,28)\frac{mGy}{nC}\ (0,925)$$
$$= 9,978\ mGy/MU$$
$$= 0,998\ cGy/MU$$

f. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0,998)\frac{cGy}{MU}\ /99,73$$
$$= 1,001\ cGy/MU$$

g. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (Z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{1,001\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= -0,001 \times 100\%$$
$$= 0,1\ \%$$

2.2.5 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 9 MeV dengan luas lapangan (25x25) cm^2

a. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0)} \frac{P_0}{P}$$
$$= \frac{(273{,}15 + 20{,}5\ °C)}{(273{,}15 + 20\ °C)} \frac{101{,}325\ kPa}{101{,}3\ kPa}$$
$$= \frac{293{,}65}{293{,}15}\ 1$$
$$= 1{,}002$$

b. Perhitungan K_{pol}

$$K_{pol} = \frac{|M_+ + M_-|}{2M}$$
$$= \frac{|12{,}17 + 12{,}20|}{2(12{,}11)}$$
$$= \frac{24{,}37}{24{,}22}$$
$$= 1{,}006$$

c. Perhitungan K_s

$$K_s = a_0 + a_1 \left(\frac{M_1}{M_2}\right) + a_2 \left(\frac{M_1}{M_2}\right)^2$$
$$= 1{,}198 + (-0{,}875) \left(\frac{12{,}20}{12{,}04}\right) + 0{,}677 \left(\frac{12{,}20}{12{,}04}\right)^2$$
$$= 1{,}198 - 0{,}875\ (1{,}013) + 0{,}677\ (1{,}027)$$
$$= 1{,}198 - 0{,}886 + 0{,}695$$
$$= 1{,}007$$

d. Perhitungan M_Q

$$M_Q = M_1\ K_{TP}\ K_{elec}\ K_{pol}\ K_s$$
$$= (12{,}20) \frac{nc}{100\ MU} (1{,}002)(1)(1{,}006)(1{,}007)$$
$$= 12{,}384\ \frac{nc}{100\ MU}$$
$$= 0{,}123\ nc/MU$$

e. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$$
$$= (0{,}125) \frac{nc}{MU}\ (84{,}28) \frac{mGy}{nC}\ (0{,}925)$$
$$= 9{,}745\ mGy/MU$$
$$= 0,975\ cGy/MU$$

f. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0{,}975) \frac{cGy}{MU}\ /100$$

$= 0{,}975\ cGy/MU$

g. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (Z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$

$$= \frac{0{,}975\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$

$$= -0{,}025 \times 100\%$$

$$= 2{,}5\ \%$$

2.3.1 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 12 MeV dengan luas lapangan (6x6) cm^2

a. Perhitungan kedalaman referensi (Z_{ref})

$Z_{ref} = 0{,}6.\ R_{50} -\ 0{,}1\ g/cm^2$

$= 0{,}6.\ 5{,}014 -\ 0{,}1\ g/cm^2$

$= 2{,}91\ g/cm^2$

b. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0\ )}\ \frac{P_0}{P}$$

$$= \frac{(273{,}15 + 20{,}5\ °C)}{(273{,}15 + 20\ °C)}\ \frac{101{,}325\ kPa}{101{,}3\ kPa}$$

$$= \frac{293{,}65}{293{,}15}\ 1$$

$$= 1{,}002$$

c. Perhitungan K_{pol}

$$K_{pol} = \frac{\left|M_+ + M_-\right|}{2M}$$

$$= \frac{|12{,}34 + 12{,}38|}{2(12{,}35)}$$

$$= \frac{24{,}72}{24{,}7}$$

$$= 1{,}008$$

d. Perhitungan K_s

$$K_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2$$

$$= 1{,}198 + (-0{,}875)\left(\frac{12{,}38}{12{,}26}\right) + 0{,}677\left(\frac{12{,}38}{12{,}26}\right)^2$$

$$= 1{,}198 - 0{,}875\ (1{,}009) + 0{,}677\ (1{,}019)$$

$$= 1{,}198 - 0{,}883 + 0{,}698$$

$$= 1{,}004$$

e. Perhitungan M_Q

$$M_Q = M_1\, K_{TP}\, K_{elec}\, K_{pol}\, K_s$$
$$= (12{,}38)\frac{nc}{100\ MU}(1{,}002)(1)(1{,}008)(1{,}004)$$
$$= 12{,}554\ \frac{nc}{100\ MU}$$
$$= 0{,}125\ nc/MU$$

f. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q\, N_{D,W,Q0}\, K_{Q,Q0}$$
$$= (0{,}125)\frac{nc}{MU}\ (84{,}28)\frac{mGy}{nC}\ (0{,}912)$$
$$= 9{,}608\ mGy/MU$$
$$= 0{,}961\ cGy/MU$$

g. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0{,}961)\frac{cGy}{MU}\ /99{,}85$$
$$= 0{,}963\ cGy/MU$$

h. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (Z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{0{,}963\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= -0{,}037 \times 100\%$$
$$= 3{,}7\%$$

2.3.2 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 12 MeV dengan luas lapangan (10x10) cm^2

a. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0\ )}\ \frac{P_0}{P}$$
$$= \frac{(273{,}15 + 20{,}8\ °C)}{(273{,}15 + 20\ °C)}\ \frac{101{,}325\ kPa}{101{,}3\ kPa}$$
$$= \frac{293{,}95}{293{,}15}\ 1$$
$$= 1{,}003$$

b. Perhitungan K_{pol}

$$K_{pol} = \frac{\left|M_+ + M_-\right|}{2M}$$
$$= \frac{|12{,}84 + 12{,}87|}{2(12{,}77)}$$

$$= \frac{25{,}71}{25{,}54}$$
$$= 1{,}006$$

c. Perhitungan K_s

$$K_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2$$
$$= 1{,}198 + (-0{,}875)\left(\frac{12{,}87}{12{,}69}\right) + 0{,}677\left(\frac{12{,}87}{12{,}69}\right)^2$$
$$= 1{,}198 - 0{,}875\ (1{,}014) + 0{,}677\ (1{,}028)$$
$$= 1{,}198 - 0{,}887 + 0{,}696$$
$$= 1{,}007$$

d. Perhitungan M_Q

$$M_Q = M_1\ K_{TP}\ K_{elec}\ K_{pol}\ K_s$$
$$= (12{,}87)\frac{nc}{100\ MU}(1{,}003)(1)(1{,}006)(1{,}007)$$
$$= 13{,}077\ \frac{nc}{100\ MU}$$
$$= 0{,}131\ nc/MU$$

e. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$$
$$= (0{,}132)\frac{nc}{MU}\ (84{,}28)\frac{mGy}{nC}\ (0{,}912)$$
$$= 10{,}146\ mGy/MU$$
$$= 1{,}014\ cGy/MU$$

f. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (1{,}014)\frac{cGy}{MU}\ /99{,}93$$
$$= 1{,}015\ cGy/MU$$

g. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (z_{max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{1{,}015\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= 0{,}015 \times 100\%$$
$$= 1{,}5\ \%$$

2.3.2 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 12 MeV dengan luas lapangan (15x15) cm^2

a. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0)} \frac{P_0}{P}$$
$$= \frac{(273{,}15 + 20{,}3\ °C)}{(273{,}15 + 20\ °C)} \frac{101{,}325\ kPa}{101{,}3\ kPa}$$
$$= \frac{293{,}45}{293{,}15}\ 1$$
$$= 1{,}001$$

b. Perhitungan K_{pol}

$$K_{pol} = \frac{|M_+ + M_-|}{2M}$$
$$= \frac{|12{,}75 + 12{,}74|}{2(12{,}65)}$$
$$= \frac{25{,}49}{25{,}3}$$
$$= 1{,}007$$

c. Perhitungan K_s

$$K_s = a_0 + a_1 \left(\frac{M_1}{M_2}\right) + a_2 \left(\frac{M_1}{M_2}\right)^2$$
$$= 1{,}198 + (-0{,}875) \left(\frac{12{,}74}{12{,}57}\right) + 0{,}677 \left(\frac{12{,}74}{12{,}57}\right)^2$$
$$= 1{,}198 - 0{,}875\ (1{,}014) + 0{,}677\ (1{,}027)$$
$$= 1{,}198 - 0{,}887 + 0{,}695$$
$$= 1{,}006$$

d. Perhitungan M_Q

$$M_Q = M_1\ K_{TP}\ K_{elec}\ K_{pol}\ K_s$$
$$= (12{,}74) \frac{nc}{100\ MU} (1{,}001)(1)(1{,}007)(1{,}006)$$
$$= 12{,}919\ \frac{nc}{100\ MU}$$
$$= 0{,}129\ nc/MU$$

e. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$$
$$= (0{,}131) \frac{nc}{MU}\ (84{,}28) \frac{mGy}{nC}\ (0{,}912)$$
$$= 10{,}069\ mGy/MU$$
$$= 1{,}007\ cGy/MU$$

f. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (1{,}007) \frac{cGy}{MU}\ /99{,}95$$

$= 1{,}007\ cGy/MU$

g. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (Z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times 100\%$$
$$= \frac{1{,}007\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times 100\%$$
$$= 0{,}007 \times 100\%$$
$$= 0{,}7\ \%$$

2.3.4 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 12 MeV dengan luas lapangan (20x20) cm^2

a. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0)} \frac{P_0}{P}$$
$$= \frac{(273{,}15 + 20{,}3\ °C)}{(273{,}15 + 20\ °C)} \frac{101{,}325\ kPa}{101{,}3\ kPa}$$
$$= \frac{293{,}45}{293{,}15}\ 1$$
$$= 1{,}001$$

b. Perhitungan K_{pol}

$$K_{pol} = \frac{\left|M_+ + M_-\right|}{2M}$$
$$= \frac{|12{,}53 + 12{,}54|}{2(12{,}55)}$$
$$= \frac{25{,}07}{25{,}1}$$
$$= 0{,}998$$

c. Perhitungan K_s

$$K_s = a_0 + a_1 \left(\frac{M_1}{M_2}\right) + a_2 \left(\frac{M_1}{M_2}\right)^2$$
$$= 1{,}198 + (-0{,}875) \left(\frac{12{,}54}{12{,}39}\right) + 0{,}677 \left(\frac{12{,}54}{12{,}39}\right)^2$$
$$= 1{,}198 - 0{,}875\ (1{,}012) + 0{,}677\ (1{,}024)$$
$$= 1{,}198 - 0{,}885 + 0{,}693$$
$$= 1{,}006$$

d. Perhitungan M_Q

$$M_Q = M_1\ K_{TP}\ K_{elec}\ K_{pol}\ K_s$$
$$= (12{,}54) \frac{nc}{100\ MU} (1{,}001)(1)(0{,}998)(1{,}006)$$
$$= 12{,}603\ \frac{nc}{100\ MU}$$
$$= 0{,}126\ nc/MU$$

e. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$$
$$= (0{,}127)\frac{nc}{MU}\ (84{,}28)\frac{mGy}{nC}\ (0{,}912)$$
$$= 9{,}762\ mGy/MU$$
$$= 0{,}976\ cGy/MU$$

f. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0{,}976)\frac{cGy}{MU}\ /99{,}79$$
$$= 0{,}978\ cGy/MU$$

g. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (Z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{0{,}978\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= -0{,}022 \times 100\%$$
$$= 2{,}2\ \%$$

2.3.4 Perhitungan nilai kedalaman Z_{ref}, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, dan Deviasi, energi 12 MeV dengan luas lapangan (25x25) cm^2

a. Perhitungan K_{TP}

$$K_{TP} = \frac{(273{,}15 + T)}{(273{,}15 + T_0\ )}\ \frac{P_0}{P}$$
$$= \frac{(273{,}15 + 20{,}6\ °C)}{(273{,}15 + 20\ °C)}\ \frac{101{,}325\ kPa}{101{,}3\ kPa}$$
$$= \frac{293{,}75}{293{,}15}\ 1$$
$$= 1{,}002$$

b. Perhitungan K_{pol}

$$K_{pol} = \frac{\left|M_+ + M_-\right|}{2M}$$
$$= \frac{|12{,}45 + 12{,}45|}{2(12{,}38)}$$
$$= \frac{24{,}9}{24{,}76}$$
$$= 1{,}006$$

c. Perhitungan K_s

$$K_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2$$

$$= 1{,}198 + (-0{,}875)\left(\frac{12{,}45}{12{,}35}\right) + 0{,}677\left(\frac{12{,}45}{12{,}35}\right)^2$$
$$= 1{,}198 - 0{,}875\ (1{,}008) + 0{,}677\ (1{,}016)$$
$$= 1{,}198 - 0{,}882 + 0{,}688$$
$$= 1{,}004$$

d. Perhitungan M_Q

$$M_Q = M_1\ K_{TP}\ K_{elec}\ K_{pol}\ K_s$$
$$= (12{,}45)\frac{nc}{100\ MU}(1{,}002)(1)(1{,}006)(1{,}004)$$
$$= 12{,}599\ \frac{nc}{100\ MU}$$
$$= 0{,}126\ nc/MU$$

e. Perhitungan $D_{W,Q\ (zref)}$

$$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$$
$$= (0{,}126)\frac{nc}{MU}\ (84{,}28)\frac{mGy}{nC}\ (0{,}912)$$
$$= 9{,}685\ mGy/MU$$
$$= 0,968\ cGy/MU$$

f. Perhitungan $D_{W,Q(zmax)}$

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$
$$= 100\ (0{,}968)\frac{cGy}{MU}\ /99{,}98$$
$$= 0{,}968\ cGy/MU$$

g. Perhitungan Deviasi

$$Deviasi = \frac{D_{W,Q\ (Z_{\max})} - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= \frac{0{,}968\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times\ 100\%$$
$$= -0{,}032 \times 100\%$$
$$= 3{,}2\ \%$$

Lampiran 3. Tabel 8 TRS 398, Kondisi Referensi Yang Direkomendasikan Untuk Kalibrasi *Ion Chamber*

Influence quantity	Reference value or reference characteristic	
	Low energy X rays	Medium energy X rays
Phantom material	PMMA or water equivalent plastic	Water
Phantom size	12 cm × 12 cm × 6 cm	30 cm × 30 cm × 30 cm (approximately)
Source–surface distance (SSD)	Treatment distance as specified by the user[a]	Treatment distance as specified by the user[a]
Air temperature[b]	20°C[c]	20°C[c]
Air pressure	101.3 kPa	101.3 kPa
Reference point of the ionization chamber	For plane-parallel ionization chambers, the centre of the outside of the front window (or the outside of any additional buildup foil)	For cylindrical chambers, on the central axis at the centre of the cavity volume
Depth in phantom of the reference point of the chamber	Surface	2 g/cm^2
Field size at the position of the reference point of the chamber[d]	3 cm × 3 cm or 3 cm diameter	10 cm × 10 cm
Relative humidity	50%	50%
Polarizing voltage and polarity	No reference values are recommended, but the values used should be stated in the calibration certificate.	
Dose rate	No reference values are recommended, but the dose rate used should always be stated in the calibration certificate. It should also be stated whether a recombination correction has or has not been applied and if so, the value should be stated.	

Lampiran 4.Tabel 9 TRS 398 Koefisien Kuadratik Pada Perhitungan Nilai K_s

V_1/V_2	Pulsed			Pulsed–scanned		
	a_0	a_1	a_2	a_0	a_1	a_2
2.0	2.337	−3.636	2.299	4.711	−8.242	4.533
2.5	1.474	−1.587	1.114	2.719	−3.977	2.261
3.0	1.198	−0.875	0.677	2.001	−2.402	1.404
3.5	1.080	−0.542	0.463	1.665	−1.647	0.984
4.0	1.022	−0.363	0.341	1.468	−1.200	0.734
5.0	0.975	−0.188	0.214	1.279	−0.750	0.474

Lampiran 5. Tabel 16 TRS 398 Kondisi Referensi Untuk Penentuan Kualitas Berkas Elektron (R_{50})

Influence quantity	Reference value or reference characteristics
Phantom material	For $R_{50} \geq 4$ g/cm^2, water
	For $R_{50} < 4$ g/cm^2, water or plastic
Chamber type	For $R_{50} \geq 4$ g/cm^2, plane parallel or cylindrical
	For $R_{50} < 4$ g/cm^2, plane parallel
Reference point of the chamber	For plane parallel chambers, on the inner surface of the window at its centre.
	For cylindrical chambers, on the central axis at the centre of the cavity volume
Position of the reference point of the chamber	For plane-parallel chambers, at the point of interest For cylindrical chambers, 0.5 r_{cyl} deeper than the point of interest
SSD	100 cm
Field size at phantom surface	For $R_{50} \leq 7$ g/cm^2, at least 10 cm × 10 cm
	For $R_{50} > 7$ g/cm^2, at least 20 cm × 20 cm[a]

Lampiran 6. Tabel 17 TRS 398 Kondisi Referensi Penentuan Dosis Terserap Pada Berkas Elektron

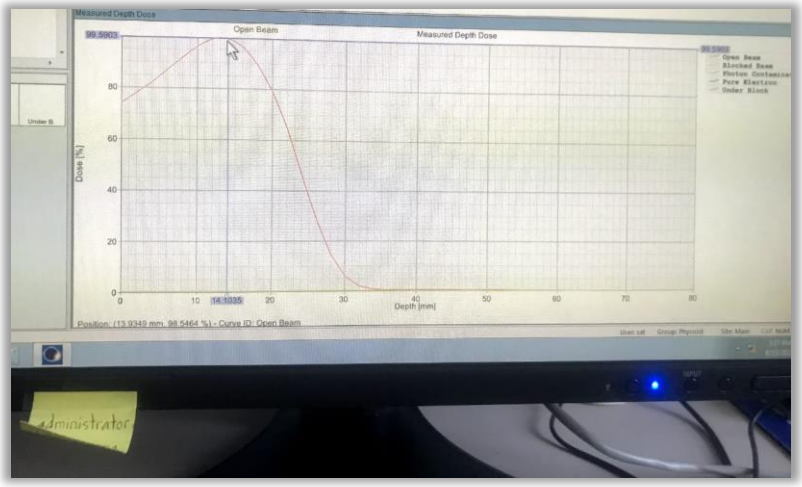
Influence quantity	Reference value or reference characteristic
Phantom material	For $R_{50} \geq 4$ g/cm^2, water For $R_{50} < 4$ g/cm^2, water or plastic
Chamber type	For $R_{50} \geq 4$ g/cm^2, plane parallel or cylindrical For $R_{50} < 4$ g/cm^2, plane parallel
Measurement depth z_{ref}	$0.6\,R_{50} - 0.1$ g/cm^2
Reference point of the chamber	For plane-parallel chambers, on the inner surface of the window at its centre For cylindrical chambers, on the central axis at the centre of the cavity volume
Position of the reference point of the chamber	For plane-parallel chambers, at z_{ref} For cylindrical chambers, $0.5r_{cyl}$ deeper than z_{ref}
SSD	100 cm
Field size at phantom surface	10 cm × 10 cm or that used for normalization of output factors, whichever is larger

Lampiran 7. Tabel 18 TRS 398 Nilai K_Q Sebagai Fungsi Kualitas Berkas Elektron R_{50}

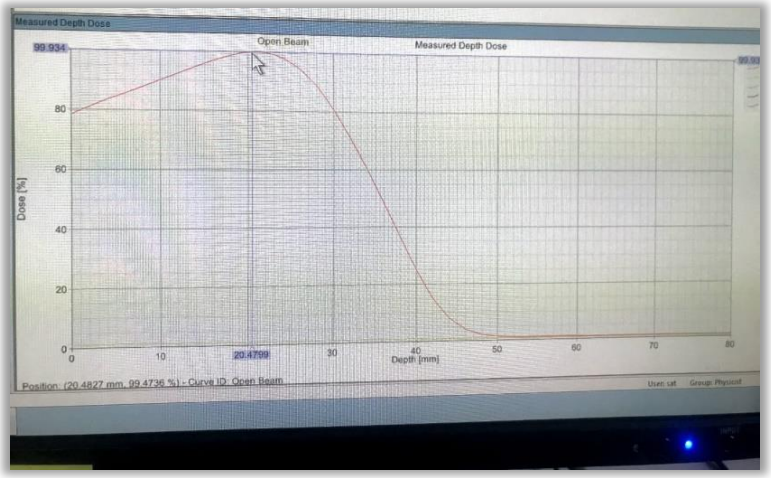
Ionization chamber type[a]	Beam quality R_{50} (g/cm^2)																
	1.0	1.4	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0	10.0	13.0	16.0	20.0
Plane-parallel chambers																	
Attix RMI 449	0.953	0.943	0.932	0.925	0.919	0.913	0.908	0.904	0.900	0.896	0.893	0.886	0.881	0.871	0.859	0.849	0.837
Capintec PS-033	—	—	0.921	0.920	0.919	0.918	0.917	0.916	0.915	0.913	0.912	0.908	0.905	0.898	0.887	0.877	0.866
Exradin P11	0.958	0.948	0.937	0.930	0.923	0.918	0.913	0.908	0.904	0.901	0.897	0.891	0.885	0.875	0.863	0.853	0.841
Holt (Memorial)	0.971	0.961	0.950	0.942	0.936	0.931	0.926	0.921	0.917	0.913	0.910	0.903	0.897	0.887	0.875	0.865	0.853
NACP / Calcam	0.952	0.942	0.931	0.924	0.918	0.912	0.908	0.903	0.899	0.895	0.892	0.886	0.880	0.870	0.858	0.848	0.836
Markus	—	—	0.925	0.920	0.916	0.913	0.910	0.907	0.904	0.901	0.899	0.894	0.889	0.881	0.870	0.860	0.849
Roos	0.965	0.955	0.944	0.937	0.931	0.925	0.920	0.916	0.912	0.908	0.904	0.898	0.892	0.882	0.870	0.860	0.848
Cylindrical chambers																	
Capintec PR06C (Farmer)	—	—	—	—	—	—	0.916	0.914	0.912	0.911	0.909	0.906	0.904	0.899	0.891	0.884	0.874
Exradin A2 (Spokas)	—	—	—	—	—	—	0.914	0.913	0.913	0.913	0.912	0.911	0.910	0.908	0.903	0.897	0.888
Exradin T2 (Spokas)	—	—	—	—	—	—	0.882	0.881	0.881	0.881	0.880	0.879	0.878	0.876	0.871	0.865	0.857
Exradin A12 (Farmer)	—	—	—	—	—	—	0.921	0.919	0.918	0.916	0.914	0.911	0.909	0.903	0.896	0.888	0.878
NE 2571 (Guarded Farmer)	—	—	—	—	—	—	0.918	0.916	0.915	0.913	0.911	0.909	0.906	0.901	0.893	0.886	0.876
NE 2581 (Robust Farmer)	—	—	—	—	—	—	0.899	0.898	0.896	0.894	0.893	0.890	0.888	0.882	0.875	0.868	0.859

Lampiran 8. Gambar grafik PDD

Kedalaman 1,41 cm utuk energi 6 MeV pada luas lapangan (6x6)cm^2



Kedalaman 2,05 cm utuk energi 9 MeV pada luas lapangan (10x10)cm^2



Kedalaman 2,91 cm utuk energi 12 MeV pada luas lapangan (15x15)cm^2