DAFTAR PUSTAKA

[1] B. H Suharmono, I. Y Anggraini, Hilmaniyya, & Suryani. “Quality Assurance (QA) dan Quality Control (QC) Pada Instrumen Radioterapi Pesawat LINAC”. *Jurnal Biosans Pascasarjana* 22(2), 2020.

[2] E. Primadila, D. Malvita, H. Prasetio, M. A. J. Kannie. “Estimasi Dosis Radiasi 3D Energi Foton Berbasis *Percentage Depth Dose* (PDD) dan *Profile Dose* untuk *Treatment Planning System* (TPS) Pesawat LINAC”. *Jurnal Fisaka Unand* (JFU), 9(3). 323-330, 2020.

[3] Nurhayati, & N. N Mulyaningsih. “Penerapan Radioterapi Pada Pengobatan Kanker Payudara”. *Jurnal Ilmiah Mahasiswa Pendidikan Fisika* (1)(2), 2020

[4] N. Fitriatuzzakiyyah, R. K Sinuraya, & I. M Puspitasari. “Terapi Kanker dengan Radiasi: Konsep Dasar Radioterapi dan Perkembangannya di Indonesia”. *Jurnal Farmasi Klinik Indonesia,* 6(4), 311-320. 2017.

[5] O. D. R Kawurung, G. Maslebu, S. Trihandaru & Hidayatullah, M. “Analisis dan Penetuan Faktor Koreksi Dosis pada Medium *Solid Water Phantom* terhadap *Water Phantom*”. *Jurnal Fisika FLUX,* 15(1), 2018.

[6] N. Sumitra, D. Milvita, & M. A. J Kanie. “Analisis Kurva *Profile Dose* Menggunakan Lapangan Radiasi Elektron pada Pesawat LINAC Tipe Clinac-Cx di Rs Unand”. *Jurnal Fisika Unand* 9(1), 73-78, 2020.

[7] M. Vadila, & D. Milvita. “Analisis Keluaran Berkas Elektron Pesawat Terapi LINAC Tipe Varian CX 6264 di Rumah Sakit Universitas Andalas”. *Jurnal Fisika Unand* 7(2), 2018.

[8] R. A Puspitasari, dkk. “Analisis Kualitas Berkas Radiasi LINAC Untuk Effektivitas Radioterapi”. *Jurnal Biosains Pascasarjana* 22(1), 2020.

[9] S. T. M Famani, G. Maslebu, S. Trihandaru, & M. Hidayatullah. “Analisis Efek Dosimetri dan Jarak dari Penggabungan Lapangan Foton 6 MV dan

Lapangan Elektron 8 MeV pada Terapi *Ca Mammae*". *Jurnal Fisika FLUX,* 15(2), 2018.

[10] D. Milvita, A. Mahyudin, & M. Vadila. "Analisis Keluaran Berkas Radiasi Sinar-X Pesawat Terapi Linac Berdasarkan TRS 398 IAEA pada Fantom Air di Instalasi Radioterapi RS Universitas Andalas". *Jurnal Ilmu Fisika* 10(2), 2018.

[11] M. Vadila. *Analisis Keluaran Berkas Radiasi Pesawat Terapi Linac Tipe Varian Cx 6264 Di Rs Unand*. Skripsi, Departemen Fisika, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Padang, Padang, 2018.

[12] D. Milvita, A. Mahyudin & V. Alvionita. "Analisis Nilai *Percentage Depth Dose* (PDD) terhadap Variasi Kedalaman Target dan Luas Lapangan Penyinaran Menggunakan Pesawat Linac-Cx". *Komunikasi Fisika Indonesia*, 15(2), 2018.

[13] I. Wulandari, M. A. Shafii, R. Adrial & F. Diyona. "Distribusi Dosis Radiasi Foton Berdasarkan Kedalaman dan Luas Lapangan Penyinaran Pada Fantom Menggunakan Pesawat Linac Tipe Clinac CX". *Jurnal Fisika Unand,* Vol. 1 (11), 2018.

[14] A. Pelawi, Sianturi, H. A. Sianturi, M. Rianna, K. Sebayang, & N. Noer. "Analysis of 6 MV Energy Quality File Index using Percentage Depth Dose (PDD) and Tissue Phantom Ratio (TPR) Methods on Linac Siemens and Electa". *International Journal of Sciences: Basic and Applied Research* (IJSBAR) 13(2), 10-14. 2018.

[15] M. Mayerni, A. Ahmad & Z. Abidin. "Dampak Radiasi Terhadap Kesehatan Pekerja Radiasi Di RSUD Arifin Achmad, RS Santa Maria Dan RS Awal Bros Pekanbaru". *Jurnal Ilmu Lingkungan,* 7(1), 2013.

[16] I. B. A Swamardika. "Pengaruh Radiasi Gelombang Elektromagnetik terhadap Kesehatan Manusia". *Jurnal Teknologi Elektro* 8(1), 2009.

[17] I. Hasan, & H.M Djakaria. “Tinjauan Pustaka: Kematian Sel Akibat Radiasi”. *Jurnal of the Indonesian Radiation Oncology Society,* Vol 4 (2). 2013.

[18] E. Widayanti. *Analisis Dosis Serap Radiasi Foto Thorax pada Pasien Anak di Instalasi Radiologi Rumah Sakut Paru Jember.* Skripsi, Jurusan Fisika, Universitas Jember, Jember, 2013.

[19] K. Guo, A Baidak & Z Yu. “Recent Advances in Green Synthesis and Modification of Inorganic 2 Nanomaterials by Ionizing and Non-Ionizing Radiations”. *Journal of Materials Chemistry A,* 2020.

[20] N. H. Wijaya, W. Kartika & A. R. D Utari. “Deteksi Radiasi Gelombang Elektromagnetik dari Peralatan Medis dan Elektronik di Rumah Sakit” *Journal ECOTIPE,* 6(2), 102-106, 2019.

[21] D. A Pratiwi, Indriyani, & Yunawati. “Penerapan Proteksi Radiasi di Instalasi Radiologi Rumah Sakit”. *Higeia Journal of Public Health Research and Development,* 5(3), 2021.

[22] K. H. Mild, R. Lundstrom & J. Wilen. “Non-Ionizing Radiation in Swedish Health Care—Exposure and Safety Aspects”. *International Journal of Environmental Research and Public Health, 16,* 2019.

[23] W. S. B Hadi & D. Malvita. “Verifikasi Luas Lapangan Radiasi Penyinaran Linac Tipe Clinic CX Terintegrasi *Electronic Portal Imaging Device* (EPID) menggunakan Teknik IMRT di RS Universitas Andalas”. *Jurnal Fisika Unand* 7(4), 2018.

[24] E. L. Dorman. “Radiotheraphy and Wound Healing”. *International Wound Journal,* 5(2), 2005.

[25] D. H. Sidabutar, & E. Setiawati. “Perbandingan Dosis terhadap Variasi Kedalaman dan Luas Lapangan Penyinaran (Bentuk Persegi dan Persegi

Panjang) pada Pesawat Radioterapi Cobalt-60". *Youngster Physics Journal*, 3(4), 295-302, 2014.

[26] M. Handayani, D. Milvita, S. Herlinda, & K. Y. P Sandy. "Verifikasi Ketetapan hasil Perencanaan Nilai Dosis Radiasi terhadap Penerimaan Dosis Radiasi pada Pasien Kanker". *Jurnal Fisika Unand* 5(2). 2016.

[27] R. A. Wibowo, B. Haris, C. A. P Winarya, & K. Ain. "Distribution of Brachytherapy Doses for Cervical Cancer using Vaginal Cylinder and Ovoid Applicators". *Journal of Physics: Conference Series,* 2018

[28] D. Milvita, N. Sumitra, & M. A. J Kanie. "Analisis kurva *Percentage Depth Dose* (PDD) menggunakan Berkas Elektron 9,12,15 dan 18 MeV pada Pesawat Linac Tipe Clinac-Cx di Rumah Sakit Universitas Andalas". *Prosiding Seminar Nasional Fisika*, 468-472, 2019.

[29] I. Paningaran. *Analisis Dosis Output Sinar-X Pesawat Linear Accelerator (Linac) Menggunakan Water Phantom*. Skripsi, Departemen Fisika, fakultas Ilmu Pengetahuan Alam, Universitas Hasanuddin, Makassar, 2015.

[30] Winarno, V. A. Nurmansya, Z. Miskiyah. "Radioterapi Kanker Cervix dengan *Linear Accelerator* (LINAC)". *Jurnal Biosains Pascasarjana,* 3(4), 24-35, 2021.

[31] Darmawati, Suharni. "Implementasi *Linear Accelerator* dalam Penanganan Kasus Kanker". *Prosiding Pertemuan dan Presentasi Ilmiah Teknologi Akselerator dan Aplikasinya*, 4, 46-47, 2012.

[32] E. B Podgorsak. 2005. Radiation Oncology Physics: A Handbook for Teacher and Students. International Atomic Energy Agency. Vienna, Austria.

[33] R. Fitriani, K. Subagiada, S. Muliyono, R. J. Stevenly, Suryaningsih. "Analisis Penggunaan Bolus Berbahan Plastisin pada Pasien *Fibrosarcoma*

dengan *Treatment Planning System* (TPS)". *Progressive Physics Journal*, 3(10, 100-109, 2022.

[34] DH Sidabutar, & E. Setiawati. "Perbandingan Dosis terhadap Variasi Kedalaman dan Luas Lapangan Penyinaran (Bentuk Persegi dan Persegi Panjang) pada Pesawat Radioterapi Cobalt-60". *Youngster Physics Journal*, 3(4), 295-302, 2014.

[35] M. AR Budi, E. Hidayanto & V. Richardina. "Analisis Pengaruh Radiasi di Ruang Penyinaran Radioterapi RSUP dr. Hasan Sadikin Bandung". *Youster Physics Journal*, 7(2), 108-116, 2018.

[36] A. Nabilla, D. Milvita & Mursiyatun. "Analisis Perbandingan Dosis Keluaran Berkas Radiasi Pesawat Co-60 Merek *Theratron Phoenix* Dari Perubahan Nilai Panjang Dan Lebar Persegi Panjang Pada Luas Lapangan Yang Sama". *Prosiding SNFA (Seminar Nasional Fisika dan Aplikasinya)*, 2020.

[37] TRS 398. 2000. Absorbed Dose Determination in External Beam Radiotheraphy. IAEA. Vienna, Austria.

LAMPIRAN

Lampiran 1. Data pengukuran jumlah nilai muatan pada berkas foton

1.1. Kedalaman 100 mm

No	Luas Lapangan	Volt (V)	P (kPa)	T (°C)	RH (%)	M (nC/100 MU)
						100 mm
1	(5 x 5) cm^2	300	101.3	20.4	60	11.43
						11.43
						11.44
		Rata-rata				11.43
		-300	101.3	20.4	60	11.43
						11.43
						11.44
		Rata-rata				11.43
		-100	101.3	20.4	60	11.36
						11.37
						11.38
		Rata-rata				11.37
2	(10 x 10) cm^2	300	101.3	20.2	60	12.85
						12.85
						12.86
		Rata-rata				12.85
		-300	101.3	20.2	60	12.85
						12.87
						12.88
		Rata-rata				12.86
		-100	101.3	20.2	60	12.78
						12.78
						12.79
		Rata-rata				12.78
3	(15 x 15) cm^2	300	101.3	20.5	60	13.85
						13.86
						13.85
		Rata-rata				13.85
		-300	101.3	20.5	60	13.87
						13.88
						13.86
		Rata-rata				13.87
		-100	101.3	20.5	60	13.75
						13.76
						13.78

		Rata-rata				13.76
4	(20 x 20) cm^2	300	101.3	20.5	58	14.37
						14.38
						14.39
		Rata-rata				14.38
		-300	101.3	20.5	58	14.38
						14.39
						14.41
		Rata-rata				14.39
		-100	101.3	20.5	58	14.28
						14.29
						14.3
		Rata-rata				14.29
5	(25 x 25) cm^2	300	101.3	20.6	58	14.56
						14.56
						14.58
		Rata-rata				14.56
		-300	101.3	20.6	58	14.59
						14.6
						14.58
		Rata-rata				14.59
		-100	101.3	20.6	58	14.48
						14.49
						14.5
		Rata-rata				14.49
6	(30 x 30) cm^2	300	101.3	20.5	58	14.87
						14.88
						14.89
		Rata-rata				14.88
		-300	101.3	20.5	58	14.91
						14.91
						14.91
		Rata-rata				14.91
		-100	101.3	20.5	58	14.77
						14.79
						14.8
		Rata-rata				14.78
7	(35 x 35) cm^2	300	101.3	20.5	58	15.07
						15.06
						15.07
		Rata-rata				15.06
		-300	101.3	20.5	58	15.1

						15.11
						15.11
		Rata-rata				15.1
		-100	101.3	20.5	58	14.99
						15
						14.98
		Rata-rata				14.99

1.2. Kedalaman 200 mm

No	Luas Lapangan	Volt (V)	P (KPa)	T (°C)	RH (%)	M (nC/100 MU)
						200 mm
1	(5 x 5) cm^2	-300	101.3	24	60	6.25
						6.26
						6.27
		Rata-rata				6.26
2	(10 x 10) cm^2	-300	101.3	20.2	60	7.37
						7.36
						7.38
		Rata-rata				7.37
3	(15 x 15) cm^2	-300	101.3	20.5	60	8.2
						8.2
						8.2
		Rata-rata				8.2
4	(20 x 20) cm^2	-300	101.3	20.5	58	8.72
						8.72
						8.73
		Rata-rata				8.72
5	(25 x 25) cm^2	-300	101.3	20.6	58	9
						9
						9.02
		Rata-rata				9
6	(30 x 30) cm^2	-300	101.3	20.5	58	9.27
						9.28
						9.29
		Rata-rata				9.28
7	(35 x 35) cm^2	-300	101.3	20.5	58	9.42
						9.46
						9.46
		Rata-rata				9.44

Lampiran 2. Perhitungan nilai $TPR_{20,10}$, K_{TP}, K_{pol}, K_s, M_Q, $D_{w,Q(zref)}$, $D_{w,Q(zmax)}$, Deviasi

2.1. Perhitungan $TPR_{20,10}$

a. (5 x 5) cm^2

$TPR_{20,10}$ = 1, 2661 x $PDD_{20,10}$ – 0,0595

= 1,2661 x 0,547 – 0,0595

= 0,632

b. (10 x 10) cm^2

$TPR_{20,10}$ = 1, 2661 x $PDD_{20,10}$ – 0,0595

= 1,2661 x 0,594 – 0,0595

= 0,692

c. (15 x 15) cm^2

$TPR_{20,10}$ = 1, 2661 x $PDD_{20,10}$ – 0,0595

= 1,2661 x 0,595 – 0,0595

= 0,693

d. (20 x 20) cm^2

$TPR_{20,10}$ = 1, 2661 x $PDD_{20,10}$ – 0,0595

= 1,2661 x 0,61 – 0,0595

= 0,712

e. (25 x 25) cm^2

$TPR_{20,10}$ = 1, 2661 x $PDD_{20,10}$ – 0,0595

= 1,2661 x 0,62 – 0,0595

= 0,724

f. (30 x 30) cm^2

$TPR_{20,10}$ = 1, 2661 x $PDD_{20,10}$ – 0,0595

= 1,2661 x 0,629 – 0,0595

$= 0{,}736$

g. (35 x 35) cm^2

$TPR_{20,10} = 1{,}2661 \times PDD_{20,10} - 0{,}0595$

$= 1{,}2661 \times 0{,}634 - 0{,}0595$

$= 0{,}742$

2.2. Perhitungan K_{TP}

a. (5 x 5) cm^2

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

$$= \frac{(273{,}15 + 20{,}4\,°C)}{(273{,}15 + 20\,°C)}\,\frac{101{,}325\,kPa}{101{,}3\,kPa}$$

$$= \frac{293{,}55}{293{,}15}\,1$$

$$= 1{,}001$$

b. (10 x 10) cm^2

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

$$= \frac{(273{,}15 + 20{,}2\,°C)}{(273{,}15 + 20\,°C)}\,\frac{101{,}325\,kPa}{101{,}3\,kPa}$$

$$= \frac{293{,}35}{293{,}15}\,1$$

$$= 1$$

c. (15 x 15) cm^2

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

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

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

$$= 1{,}001$$

d. (20 x 20) cm^2

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

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

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

$$= 1{,}001$$

e. (25 x 25) cm^2

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

$$= \frac{(273{,}15 + 20{,}6\ °C)}{(273{,}15 + 20\ °C)}\ \frac{101{,}325\ kPa}{101{,}3\ kPa}$$

$$= \frac{293{,}75}{293{,}15}\ 1$$

$$= 1{,}002$$

f. (30 x 30) cm^2

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

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

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

$$= 1{,}001$$

g. (35 x 35) cm^2

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

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

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

$$= 1{,}001$$

2.3. Perhitungan K_{pol}

a. (5 x 5) cm^2

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

$$= \frac{|11{,}43 + 11{,}43|}{2(11{,}43)}$$

$$= \frac{23{,}86}{23{,}86}$$

$$= 1$$

b. (10 x 10) cm^2

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

$$= \frac{|12{,}85 + 12{,}86|}{2(12{,}85)}$$

$$= \frac{25{,}71}{25{,}7}$$

$$= 1$$

c. (15 x 15) cm^2

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

$$= \frac{|13{,}86 + 13{,}85|}{2(13{,}86)}$$

$$= \frac{27{,}71}{27{,}72}$$

$$= 0{,}999$$

d. (20 x 20) cm^2

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

$$= \frac{|14{,}39 + 14{,}38|}{2(14{,}38)}$$

$$= \frac{28{,}77}{28{,}77}$$

$$= 1$$

e. (25 x 25) cm^2

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

$$= \frac{|14{,}56 + 14{,}59|}{2(14{,}57)}$$

$$= \frac{29{,}15}{29{,}14}$$

$$= 1$$

f. (30 x 30) cm^2

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

$$= \frac{|14{,}88 + 14{,}91|}{2(14{,}91)}$$

$$= \frac{29{,}79}{29{,}82}$$

$$= 0{,}998$$

g. (35 x 35) cm^2

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

$$= \frac{|15{,}06 + 15{,}1|}{2(15{,}09)}$$

$$= \frac{30{,}16}{30{,}18}$$

$$= 0{,}999$$

2.4. Perhitungan K$_s$

a. (5 x 5) cm^2

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

$$= 1{,}198 + (-0{,}875)\left(\frac{11{,}43}{11{,}37}\right) + 0{,}677\left(\frac{11{,}43}{11{,}37}\right)^2$$

$$= 1{,}198 - 0{,}875\ (1{,}005) + 0{,}677\ (1{,}01)$$

$$= 1{,}198 - 0{,}879 + 0{,}683$$

$$= 1{,}002$$

b. (10 x 10) cm^2

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

$$= 1{,}198 + (-0{,}875)\left(\frac{12{,}86}{12{,}78}\right) + 0{,}677\left(\frac{12{,}86}{12{,}78}\right)^2$$

$$= 1{,}198 - 0{,}875\ (1{,}006) + 0{,}677\ (1{,}012)$$

$$= 1{,}198 - 0{,}88 + 0{,}685$$

$$= 1{,}003$$

c. (15 x 15) cm^2

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

$$= 1{,}198 + (-0{,}875)\left(\frac{13{,}87}{13{,}76}\right) + 0{,}677\left(\frac{13{,}87}{13{,}76}\right)^2$$

$$= 1{,}198 - 0{,}875\ (1{,}007) + 0{,}677\ (1{,}014)$$

$$= 1{,}198 - 0{,}881 + 0{,}686$$

$$= 1{,}003$$

d. (20 x 20) cm^2

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

$$= 1{,}198 + (-0{,}875)\left(\frac{14{,}39}{14{,}29}\right) + 0{,}677\left(\frac{14{,}39}{14{,}29}\right)^2$$

$$= 1{,}198 - 0{,}875\ (1{,}007) + 0{,}677\ (1{,}014)$$

$$= 1{,}198 - 0{,}881 + 0{,}686$$

$$= 1{,}003$$

e. (25 x 25) cm^2

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

$$= 1{,}198 + (-0{,}875)\left(\frac{14{,}59}{14{,}49}\right) + 0{,}677\left(\frac{14{,}59}{14{,}49}\right)^2$$

$$= 1{,}198 - 0{,}875\ (1{,}006) + 0{,}677\ (1{,}012)$$

$$= 1{,}198 - 0{,}88 + 0{,}685$$

$$= 1{,}003$$

f. (30 x 30) cm^2

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

$$= 1,198 + (-0,875)\left(\frac{14,91}{14,78}\right) + 0,677\left(\frac{14,91}{14,78}\right)^2$$

$$= 1,198 - 0,875\ (1,008) + 0,677\ (1,016)$$

$$= 1,198 - 0,882 + 0,687$$

$$= 1,003$$

g. (35 x 35) cm^2

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

$$= 1,198 + (-0,875)\left(\frac{15,11}{14,99}\right) + 0,677\left(\frac{15,11}{14,99}\right)^2$$

$$= 1,198 - 0,875\ (1,008) + 0,677\ (1,016)$$

$$= 1,198 - 0,882 + 0,687$$

$$= 1,003$$

2.5. Perhitungan M_Q

a. (5 x 5) cm^2

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

$$= (11,43)\frac{nc}{100\ MU}(1,001)(1)(1)(1,002)$$

$$= 11,464\ \frac{nc}{100\ MU}$$

$$= 0,114\ nc/MU$$

b. (10 x 10) cm^2

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

$$= (12,86)\frac{nc}{100\ MU}(1)(1)(1)(1,003)$$

$$= 12,89\ \frac{nc}{100\ MU}$$

$$= 0,128\ nc/MU$$

c. (15 x 15) cm^2

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

$$= (13,87)\frac{nc}{100\ MU}(1,001)(1)(0.999)(1,003)$$

$$= 13,911\ \frac{nc}{100\ MU}$$

$= 0{,}139\ nc/MU$

d. (20 x 20) cm^2

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

$= (14{,}39)\dfrac{nc}{100\ MU}(1{,}001)(1)(1)(1{,}003)$

$= 14{,}45\dfrac{nc}{100\ MU}$

$= 0{,}144\ nc/MU$

e. (25 x 25) cm^2

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

$= (14{,}59)\dfrac{nc}{100\ MU}(1{,}002)(1)(1)(1{,}003)$

$= 14{,}663\ \dfrac{nc}{100\ MU}$

$= 0{,}146\ nc/MU$

f. (30 x 30) cm^2

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

$= (14{,}91)\dfrac{nc}{100\ MU}(1{,}001)(1)(0.998)(1{,}003)$

$= 14{,}939\ \dfrac{nc}{100\ MU}$

$= 0{,}149\ nc/MU$

g. (35 x 35) cm^2

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

$= (15{,}1)\dfrac{nc}{100\ MU}(1{,}001)(1)(0{,}999)(1{,}003)$

$= 15{,}14\ \dfrac{nc}{100\ MU}$

$= 0{,}151\ nc/MU$

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

a. (5 x 5) cm^2

$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$

$= (0{,}114)\dfrac{nc}{MU}\ (48{,}2)\dfrac{mGy}{nC}\ (0{,}987)$

$= 5{,}478\ mGy/MU$

$= 0{,}547\ cGy/MU$

b. (10 x 10) cm^2

$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$

$$= (0{,}128)\frac{nc}{MU}\ (48{,}2)\frac{mGy}{nC}\ (0{,}988)$$

$= 6{,}095\ mGy/MU$

$= 0{,}609\ cGy/MU$

c. (15 x 15) cm^2

$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$

$$= (0{,}139)\frac{nc}{MU}\ (48{,}2)\frac{mGy}{nC}\ (0{,}988)$$

$= 6{,}619\ mGy/MU$

$= 0{,}661\ cGy/MU$

d. (20 x 20) cm^2

$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$

$$= (0{,}144)\frac{nc}{MU}\ (48{,}2)\frac{mGy}{nC}\ (0{,}984)$$

$= 6{,}829\ mGy/MU$

$= 0{,}682\ cGy/MU$

e. (25 x 25) cm^2

$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$

$$= (0{,}146)\frac{nc}{MU}\ (48{,}2)\frac{mGy}{nC}\ (0{,}984)$$

$= 6{,}924\ mGy/MU$

$= 0{,}692\ cGy/MU$

f. (30 x 30) cm^2

$D_{W,Q(zref)} = M_Q\ N_{D,W,Q0}\ K_{Q,Q0}$

$$= (0{,}149)\frac{nc}{MU}\ (48{,}2)\frac{mGy}{nC}\ (0{,}98)$$

$= 7{,}038\ mGy/MU$

$= 0{,}703\ cGy/MU$

g. (35 x 35) cm^2

$D_{W,Q(zref)} = M_Q \, N_{D,W,Q0} \, K_{Q,Q0}$

$= (0{,}151) \frac{nc}{MU} \; (48{,}2) \frac{mGy}{nC} \; (0{,}98)$

$= 7{,}132 \; mGy/MU$

$= 0{,}713 \; cGy/MU$

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

a. (5 x 5) cm^2

$D_{W,Q(zmax)} = 100 \; D_{W,Q(zref)} \; / \; PDD_{zref}$

$= 100 \; (0{,}547) \frac{cGy}{MU} \; / \; 63{,}15$

$= 0{,}866 \; cGy/MU$

b. (10 x 10) cm^2

$D_{W,Q(zmax)} = 100 \; D_{W,Q(zref)} \; / \; PDD_{zref}$

$= 100 \; (0{,}609) \frac{cGy}{MU} \; / \; 67{,}48$

$= 0{,}902 \; cGy/MU$

c. (15 x 15) cm^2

$D_{W,Q(zmax)} = 100 \; D_{W,Q(zref)} \; / \; PDD_{zref}$

$= 100 \; (0{,}661) \frac{cGy}{MU} \; / \; 68{,}9$

$= 0{,}959 \; cGy/MU$

d. (20 x20) cm^2

$D_{W,Q(zmax)} = 100 \; D_{W,Q(zref)} \; / \; PDD_{zref}$

$= 100 \; (0{,}682) \frac{cGy}{MU} \; / \; 70$

$= 0{,}974 \; cGy/MU$

e. (25 x 25) cm^2

$D_{W,Q(zmax)} = 100 \; D_{W,Q(zref)} \; / \; PDD_{zref}$

$= 100 \; (0{,}692) \frac{cGy}{MU} \; / \; 70{,}74$

$= 0{,}978 \; cGy/MU$

f. (30 x 30) cm^2

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$

$$= 100\ (0{,}703)\frac{cGy}{MU}\ /\ 71{,}48$$

$$= 0{,}983\ cGy/MU$$

g. (35 x 35) cm^2

$$D_{W,Q(zmax)} = 100\ D_{W,Q(zref)}\ /\ PDD_{zref}$$

$$= 100\ (0{,}713)\frac{cGy}{MU}\ /\ 71{,}97$$

$$= 0{,}99\ cGy/MU$$

2.8. Perhitungan Deviasi

a. (5 x 5) cm^2

$$Deviasi = \frac{0{,}866\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times 100\%$$

$$= -0{,}134 \times 100\%$$

$$= -13{,}4\ \%$$

b. (10 x 10) cm^2

$$Deviasi = \frac{0{,}902\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times 100\%$$

$$= -0{,}098 \times 100\%$$

$$= -9{,}8\ \%$$

c. (15 x 15) cm^2

$$Deviasi = \frac{0{,}959\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times 100\%$$

$$= -0{,}041 \times 100\%$$

$$= -4{,}1\ \%$$

d. (20 x 20) cm^2

$$Deviasi = \frac{0{,}974\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times 100\%$$

$$= 0{,}026 \times 100\%$$

$$= 2{,}6\ \%$$

e. (25 x 25) cm^2

$$Deviasi = \frac{0{,}978\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times 100\%$$

$$= 0{,}022 \times 100\%$$

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

f. (30 x 30) cm^2

$$Deviasi = \frac{0{,}983\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times 100\%$$

$$= 0{,}017 \times 100\%$$

$$= 1{,}7\ \%$$

g. (35 x 35) cm^2

$$Deviasi = \frac{0{,}99\ cGy/MU - 1\ cGy/MU}{1\ cGy/MU} \times 100\%$$

$$= 0{,}01 \times 100\%$$

$$= 1\ \%$$

Lampiran 3. Kondisi referensi yang direkomendasikan untuk kalibrasi *Ion Chamber*

Influence quantity	Reference value or reference characteristic
Phantom material	Water
Phantom size	30 cm × 30 cm × 30 cm (approximately)
Source–chamber distance[a] (SCD)	100 cm
Air temperature[b]	20°C [c]
Air pressure	101.3 kPa
Reference point of the ionization chamber	For cylindrical chambers, on the chamber axis at the centre of the cavity volume; for plane-parallel chambers on the inner surface of the entrance window, at the centre of the window.
Depth in phantom of the reference point of the chamber[a]	5 g/cm^2
Field size at the position of the reference point of the chamber	10 cm × 10 cm
Relative humidity	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. Kondisi referensi untuk penentuan kualitas berkas foton

Influence quantity	Reference value or reference characteristics
Phantom material	Water
Chamber type	Cylindrical or plane parallel
Measurement depths	20 g/cm^2 and 10 g/cm^2
Reference point of the chamber	For cylindrical chambers, on the central axis at the centre of the cavity volume. For plane-parallel chambers, on the inner surface of the window at its centre
Position of the reference point of the chamber	For cylindrical and plane-parallel chambers, at the measurement depths
SCD	100 cm
Field size at SCD	10 cm × 10 cm[a]

Lampiran 5. Tabel untuk nilai K_Q Sebagai Fungsi $TPR_{20,10}$

Ionization chamber type[a]	Beam quality $TPR_{20,10}$														
	0.50	0.53	0.56	0.59	0.62	0.65	0.68	0.70	0.72	0.74	0.76	0.78	0.80	0.82	0.84
Capintec PR-05P mini	1.004	1.003	1.002	1.001	1.000	0.998	0.996	0.994	0.991	0.987	0.983	0.975	0.968	0.960	0.949
Capintec PR-05 mini	1.004	1.003	1.002	1.001	1.000	0.998	0.996	0.994	0.991	0.987	0.983	0.975	0.968	0.960	0.949
Capintec PR-06C/G Farmer	1.001	1.001	1.000	0.998	0.998	0.995	0.992	0.990	0.988	0.984	0.980	0.972	0.965	0.956	0.944
Exradin A2 Spokas	1.001	1.001	1.001	1.000	0.999	0.997	0.996	0.994	0.992	0.989	0.986	0.979	0.971	0.962	0.949
Exradin T2 Spokas	1.002	1.001	0.999	0.996	0.993	0.988	0.984	0.980	0.977	0.973	0.969	0.962	0.954	0.946	0.934
Exradin A1 mini Shonka	1.002	1.002	1.001	1.000	1.000	0.998	0.996	0.994	0.991	0.986	0.982	0.974	0.966	0.957	0.945
Exradin T1 mini Shonka	1.003	1.001	0.999	0.996	0.993	0.988	0.984	0.980	0.975	0.970	0.965	0.957	0.949	0.942	0.930
Exradin A12 Farmer	1.001	1.001	1.000	1.000	0.999	0.997	0.994	0.992	0.990	0.986	0.981	0.974	0.966	0.957	0.944
Far West Tech. IC-18	1.005	1.003	1.000	0.997	0.993	0.988	0.983	0.979	0.976	0.971	0.966	0.959	0.953	0.945	0.934
FZH TK 01	1.002	1.001	1.000	0.998	0.996	0.993	0.990	0.987	0.984	0.980	0.975	0.968	0.960	0.952	0.939
Nuclear Assoc. 30-750	1.001	1.001	1.000	0.999	0.998	0.996	0.994	0.991	0.988	0.984	0.979	0.971	0.963	0.954	0.941
Nuclear Assoc. 30-749	1.001	1.000	1.000	0.999	0.998	0.996	0.994	0.992	0.989	0.984	0.980	0.972	0.964	0.956	0.942
Nuclear Assoc. 30-744	1.001	1.000	1.000	0.999	0.998	0.996	0.994	0.992	0.989	0.984	0.980	0.972	0.964	0.956	0.942
Nuclear Assoc. 30-716	1.001	1.000	1.000	0.999	0.998	0.996	0.994	0.992	0.989	0.984	0.980	0.972	0.964	0.956	0.942
Nuclear Assoc. 30-753 Farmer shortened	1.001	1.000	1.000	0.999	0.998	0.996	0.994	0.992	0.989	0.985	0.980	0.973	0.965	0.956	0.943
Nuclear Assoc. 30-751 Farmer	1.002	1.002	1.000	0.999	0.997	0.994	0.991	0.989	0.985	0.981	0.977	0.969	0.961	0.953	0.940
Nuclear Assoc. 30-752 Farmer	1.004	1.003	1.001	1.000	0.998	0.996	0.993	0.991	0.989	0.985	0.981	0.974	0.967	0.959	0.947

TABLE 14. (cont.)

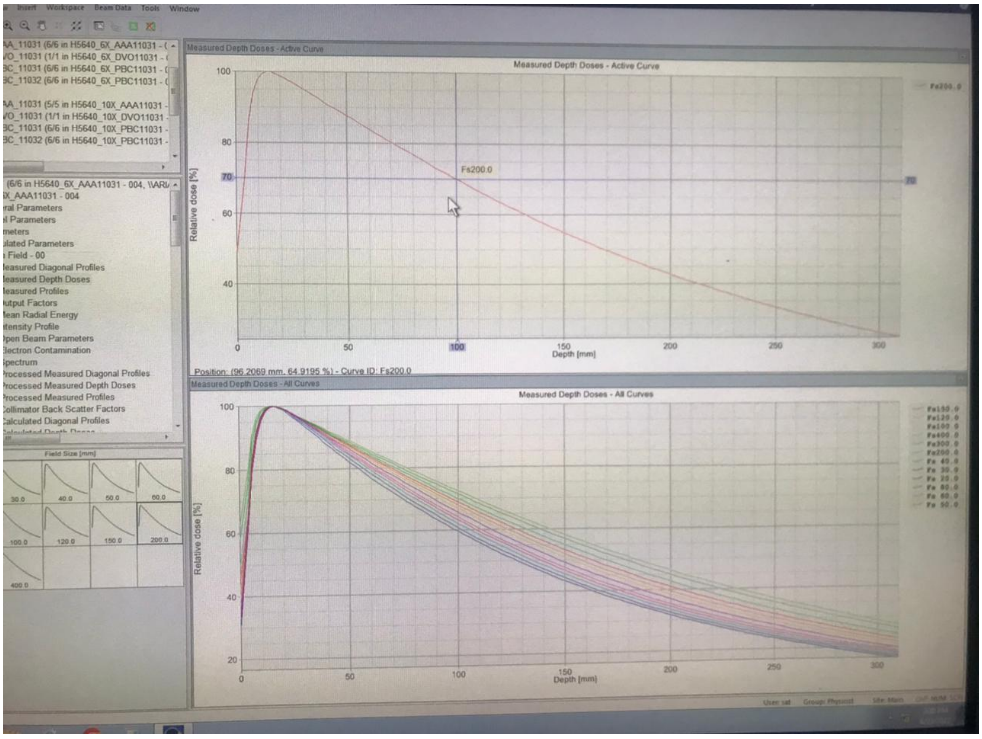
NE 2515	1.001	1.001	1.000	0.999	0.997	0.994	0.991	0.988	0.984	0.980	0.975	0.967	0.959	0.950	0.937
NE 2515/3	1.005	1.004	1.002	1.000	0.998	0.995	0.993	0.991	0.989	0.986	0.982	0.975	0.969	0.961	0.949
NE 2577	1.005	1.004	1.002	1.000	0.998	0.995	0.993	0.991	0.989	0.986	0.982	0.975	0.969	0.961	0.949
NE 2505 Farmer	1.001	1.001	1.000	0.999	0.997	0.994	0.991	0.988	0.984	0.980	0.975	0.967	0.959	0.950	0.937
NE 2505/A Farmer	1.005	1.003	1.001	0.997	0.995	0.990	0.985	0.982	0.978	0.974	0.969	0.962	0.955	0.947	0.936
NE 2505/3, 3A Farmer	1.005	1.004	1.002	1.000	0.998	0.995	0.993	0.991	0.989	0.986	0.982	0.975	0.969	0.961	0.949
NE 2505/3, 3B Farmer	1.006	1.004	1.001	0.999	0.996	0.991	0.987	0.984	0.980	0.976	0.971	0.964	0.957	0.950	0.938
NE 2571 Farmer	1.005	1.004	1.002	1.000	0.998	0.995	0.993	0.991	0.989	0.986	0.982	0.975	0.969	0.961	0.949
NE 2581 Farmer	1.005	1.003	1.001	0.998	0.995	0.991	0.986	0.983	0.980	0.975	0.970	0.963	0.956	0.949	0.937
NE 2561/2611 Sec. Std	1.006	1.004	1.001	0.999	0.998	0.994	0.992	0.990	0.988	0.985	0.982	0.975	0.969	0.961	0.949
PTW 23323 micro	1.003	1.003	1.000	0.999	0.997	0.993	0.990	0.987	0.984	0.980	0.975	0.967	0.960	0.953	0.941
PTW 23331 rigid	1.004	1.003	1.000	0.999	0.997	0.993	0.990	0.988	0.985	0.982	0.978	0.971	0.964	0.956	0.945
PTW 23332 rigid	1.004	1.003	1.001	0.999	0.997	0.994	0.990	0.988	0.984	0.980	0.976	0.968	0.961	0.954	0.943
PTW 23333	1.004	1.003	1.001	0.999	0.997	0.994	0.990	0.988	0.985	0.981	0.976	0.969	0.963	0.955	0.943
PTW 30001/30010 Farmer	1.004	1.003	1.001	0.999	0.997	0.994	0.990	0.988	0.985	0.981	0.976	0.969	0.962	0.955	0.943
PTW 30002/30011 Farmer	1.006	1.004	1.001	0.999	0.997	0.994	0.992	0.990	0.987	0.984	0.980	0.973	0.967	0.959	0.948
PTW 30004/30012 Farmer	1.006	1.005	1.002	1.000	0.999	0.996	0.994	0.992	0.989	0.986	0.982	0.976	0.969	0.962	0.950
PTW 30006/30013 Farmer	1.002	1.002	1.000	0.999	0.997	0.994	0.990	0.988	0.984	0.980	0.975	0.968	0.960	0.952	0.940
PTW 31002 flexible	1.003	1.002	1.000	0.999	0.997	0.994	0.990	0.988	0.984	0.980	0.975	0.968	0.960	0.952	0.940
PTW 31003 flexible	1.003	1.002	1.000	0.999	0.997	0.994	0.990	0.988	0.984	0.980	0.975	0.968	0.960	0.952	0.940
SNC 100730 Farmer	1.004	1.003	1.001	0.999	0.997	0.993	0.990	0.988	0.985	0.981	0.977	0.970	0.963	0.956	0.944
SNC 100740 Farmer	1.006	1.005	1.002	1.000	0.999	0.996	0.994	0.992	0.990	0.987	0.983	0.977	0.971	0.963	0.951
Victoreen Radocon III 550	1.005	1.004	1.001	0.998	0.996	0.993	0.989	0.986	0.983	0.979	0.975	0.968	0.961	0.954	0.943

Lampiran 6. Koefisien kuadratik untuk nilai K_s

V_1/V_2	Pulsed			Pulsed–scanned		
	a_o	a_1	a_2	a_o	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 7. Gambar Grafik Nilai PDD

kedalaman 100 mm



Kedalaman 200 mm