Espectro de Feixes Padrões de Radiação X nas Qualidades de Radiodiagnóstico e Mamografia a partir de Simulações Monte Carlo – Espectros dos Feixes Padrões

Título do Estudo:	Espectro de Feixes Padrões de Radiação X nas Qualidades de Radiodiagnóstico e Mamografia a partir de Simulações Monte Carlo – Espectros dos Feixes Padrões
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Assunto (Palavras-Chave):	Feixes Padrões de Radiação X; Qualidades de Radiodiagnóstico; Qualidades de Mamografia; Simulação Computacional
Instituição:	Instituto de Pesquisas Energéticas e Nucleares, Comissão Nacional de Energia Nuclear (IPEN/CNEN-SP)
Descrição:	Este estudo faz parte de um Projeto Temático
Agência de Fomento:	Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP)
Número do Processo:	Processo FAPESP nº: 2018/05982-0
Situação do Estudo:	Estes dados fazem parte de um trabalho completo submetido e aceito para apresentação no Congresso Brasileiro de Metrologia das Radiações Ionizantes – CBMRI 2020.

Espectro de Feixes Padrões de Radiação X nas Qualidades de Radiodiagnóstico e Mamografia a partir de Simulações Monte Carlo – <u>Espectros dos Feixes Padrões</u>

(Projeto Temático FAPESP - Processo nº: 2018/05982-0)

São apresentados os espectros dos feixes padrões RQRM1, RQRM2, RQRM3, RQRM4, RQR5 e RQR8 (TRS-457) simulados no software BEAMnrc, usando o código de Monte Carlo EGSnrc. Detalhes da simulação estão descritos no trabalho submetido ao congresso. Para cada espectro são informadas a fluência relativa (u.a.) de fótons para cada intervalo de energia (keV).

RQRM1		**RQRM2**		**RQRM3**		**RQRM4**	
Energia (keV)	**Fluência Relativa (u.a)**	**Energia (keV)**	**Fluência Relativa (u.a)**	**Energia (keV)**	**Fluência Relativa (u.a)**	**Energia (keV)**	**Fluência Relativa (u.a)**
0,21	9,25E-16	0,23	1,26E-15	0,25	6,83E-16	0,29	2,08E-15
0,63	9,25E-16	0,70	1,26E-15	0,75	6,83E-16	0,88	2,08E-15
1,04	9,25E-16	1,17	1,26E-15	1,25	6,83E-16	1,46	2,08E-15
1,46	9,25E-16	1,63	1,26E-15	1,75	6,83E-16	2,04	2,08E-15
1,88	9,25E-16	2,10	1,26E-15	2,25	6,83E-16	2,63	2,08E-15
2,29	9,25E-16	2,57	1,26E-15	2,75	4,10E-05	3,21	3,34E-05
2,71	9,25E-16	3,03	2,51E-05	3,25	6,83E-16	3,79	2,08E-15
3,13	9,25E-06	3,50	1,26E-15	3,75	6,83E-16	4,38	2,08E-15
3,54	9,25E-16	3,97	1,26E-15	4,25	6,83E-16	4,96	2,08E-15
3,96	9,25E-16	4,43	1,26E-15	4,75	6,83E-16	5,54	2,08E-15
4,38	9,25E-16	4,90	1,26E-15	5,25	6,83E-16	6,13	2,08E-15
4,79	9,25E-16	5,37	1,26E-15	5,75	6,83E-16	6,71	2,08E-05
5,21	9,25E-16	5,83	1,26E-05	6,25	6,83E-06	7,29	1,00E-04
5,63	9,25E-06	6,30	3,77E-05	6,75	2,05E-05	7,88	3,96E-04
6,04	3,70E-05	6,77	2,39E-04	7,25	8,20E-05	8,46	1,16E-03
6,46	2,13E-04	7,23	6,72E-04	7,75	4,17E-04	9,04	2,60E-03
6,88	5,00E-04	7,70	1,86E-03	8,25	9,01E-04	9,63	4,83E-03
7,29	9,90E-04	8,17	3,51E-03	8,75	2,29E-03	10,21	7,70E-03
7,71	2,09E-03	8,63	6,08E-03	9,25	4,43E-03	10,79	1,07E-02
8,13	3,66E-03	9,10	8,29E-03	9,75	6,65E-03	11,38	1,47E-02
8,54	5,72E-03	9,57	1,18E-02	10,25	9,26E-03	11,96	1,84E-02
8,96	8,56E-03	10,03	1,59E-02	10,75	1,26E-02	12,54	2,19E-02
9,38	1,21E-02	10,50	1,84E-02	11,25	1,62E-02	13,13	2,52E-02
9,79	1,54E-02	10,97	2,25E-02	11,75	2,01E-02	13,71	2,81E-02

10,21	1,94E-02	11,43	2,54E-02	12,25	2,37E-02	14,29	3,05E-02
10,63	2,22E-02	11,90	2,78E-02	12,75	2,63E-02	14,88	3,27E-02
11,04	2,63E-02	12,37	3,06E-02	13,25	3,02E-02	15,46	3,42E-02
11,46	2,88E-02	12,83	3,20E-02	13,75	3,08E-02	16,04	3,46E-02
11,88	3,16E-02	13,30	3,31E-02	14,25	3,45E-02	16,63	3,63E-02
12,29	3,42E-02	13,77	3,70E-02	14,75	3,64E-02	17,21	3,63E-01
12,71	3,52E-02	14,23	3,60E-02	15,25	3,53E-02	17,79	3,54E-02
13,13	3,65E-02	14,70	3,65E-02	15,75	3,75E-02	18,38	3,59E-02
13,54	3,88E-02	15,17	3,67E-02	16,25	3,84E-02	18,96	3,51E-02
13,96	3,93E-02	15,63	3,67E-02	16,75	3,88E-02	19,54	9,93E-02
14,38	3,83E-02	16,10	3,63E-02	17,25	2,93E-01	20,13	2,45E-02
14,79	3,85E-02	16,57	3,54E-02	17,75	3,73E-02	20,71	3,46E-03
15,21	3,85E-02	17,03	3,45E-02	18,25	3,75E-02	21,29	3,53E-03
15,63	3,86E-02	17,50	2,17E-01	18,75	3,62E-02	21,88	3,37E-03
16,04	3,77E-02	17,97	3,41E-02	19,25	3,63E-02	22,46	3,65E-03
16,46	3,65E-02	18,43	3,09E-02	19,75	8,95E-02	23,04	4,38E-03
16,88	3,59E-02	18,90	3,09E-02	20,25	4,72E-03	23,63	4,19E-03
17,29	1,43E-01	19,37	4,26E-02	20,75	3,36E-03	24,21	4,62E-03
17,71	3,27E-02	19,83	5,22E-02	21,25	3,57E-03	24,79	4,91E-03
18,13	3,12E-02	20,30	5,78E-03	21,75	3,26E-03	25,38	5,17E-03
18,54	3,01E-02	20,77	5,67E-03	22,25	3,24E-03	25,96	5,36E-03
18,96	2,85E-02	21,23	5,62E-03	22,75	3,59E-03	26,54	5,50E-03
19,38	2,56E-02	21,70	4,75E-03	23,25	3,95E-03	27,13	5,52E-03
19,79	4,49E-02	22,17	4,52E-03	23,75	4,12E-03	27,71	5,84E-03
20,21	6,31E-03	22,63	4,49E-03	24,25	4,20E-03	28,29	5,50E-03
20,63	4,75E-03	23,10	4,83E-03	24,75	3,95E-03	28,88	5,61E-03
21,04	4,28E-03	23,57	4,28E-03	25,25	4,36E-03	29,46	5,50E-03
21,46	4,06E-03	24,03	4,46E-03	25,75	3,60E-03	30,04	5,07E-03
21,88	4,08E-03	24,50	4,39E-03	26,25	4,13E-03	30,63	4,61E-03
22,29	3,06E-03	24,97	3,57E-03	26,75	3,28E-03	31,21	4,19E-03
22,71	3,22E-03	25,43	3,30E-03	27,25	3,53E-03	31,79	3,84E-03
23,13	2,69E-03	25,90	2,78E-03	27,75	2,91E-03	32,38	3,00E-03
23,54	2,20E-03	26,37	2,57E-03	28,25	2,18E-03	32,96	2,57E-03
23,96	1,77E-03	26,83	1,87E-03	28,75	1,62E-03	33,54	2,09E-03
24,38	1,08E-03	27,30	1,17E-03	29,25	1,33E-03	34,13	1,06E-03
24,79	7,77E-04	27,77	4,58E-04	29,75	4,10E-04	34,71	4,04E-04

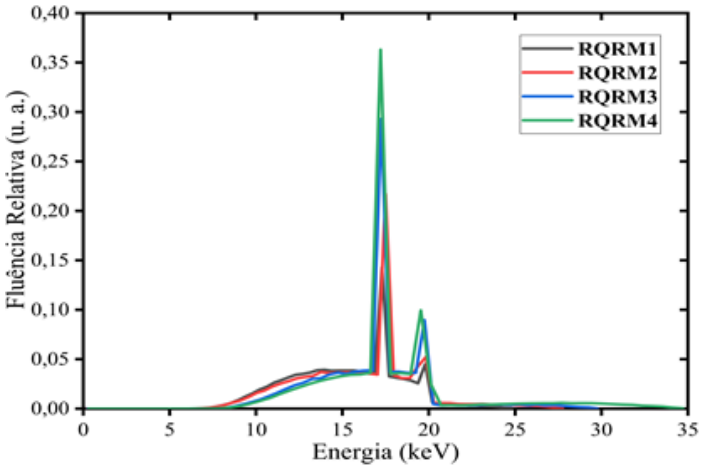

Figura 1 - Espectros dos feixes RQR M1, M2, M3 e M4 simulados no *BEAMnrc*.

RQR5		RQR8	
Energia (keV)	**Fluência Relativa (u.a)**	**Energia (keV)**	**Fluência Relativa (u.a)**
0,18	1,63E-16	0,25	7,83E-17
0,53	1,63E-16	0,75	7,83E-17
0,88	1,63E-16	1,25	7,83E-17
1,23	1,63E-16	1,75	7,83E-17
1,58	1,63E-16	2,25	7,83E-17
1,93	1,63E-16	2,75	7,83E-17
2,28	1,63E-16	3,25	2,35E-06
2,63	1,63E-16	3,75	7,83E-17
2,98	1,63E-06	4,25	7,83E-17
3,33	1,63E-16	4,75	7,83E-17
3,68	1,63E-16	5,25	7,83E-17
4,03	1,63E-16	5,75	7,83E-17
4,38	1,63E-16	6,25	7,83E-17
4,73	1,63E-16	6,75	7,83E-17
5,08	1,63E-16	7,25	7,83E-17
5,43	1,63E-16	7,75	7,83E-17
5,78	1,63E-16	8,25	7,83E-17
6,13	1,63E-16	8,75	7,83E-17
6,48	1,63E-16	9,25	7,83E-17
6,83	1,63E-16	9,75	7,83E-17
7,18	1,63E-16	10,25	7,83E-17
7,53	1,63E-16	10,75	7,83E-07
7,88	1,63E-16	11,25	7,83E-17
8,23	1,63E-16	11,75	7,83E-17

8,58	1,63E-16	12,25	7,83E-17
8,93	1,63E-06	12,75	7,83E-17
9,28	1,63E-16	13,25	7,83E-17
9,63	1,63E-16	13,75	7,83E-17
9,98	1,63E-16	14,25	7,83E-07
10,33	1,63E-16	14,75	2,35E-06
10,68	1,63E-16	15,25	4,70E-06
11,03	1,63E-16	15,75	1,25E-05
11,38	1,63E-16	16,25	2,27E-05
11,73	1,63E-16	16,75	4,93E-05
12,08	1,63E-16	17,25	8,30E-05
12,43	1,63E-06	17,75	1,30E-04
12,78	3,26E-06	18,25	2,28E-04
13,13	1,63E-16	18,75	3,12E-04
13,48	4,89E-06	19,25	4,57E-04
13,83	1,30E-05	19,75	5,73E-04
14,18	9,78E-06	20,25	7,77E-04
14,53	1,30E-05	20,75	9,53E-04
14,88	4,73E-05	21,25	1,28E-03
15,23	6,84E-05	21,75	1,57E-03
15,58	9,45E-05	22,25	1,88E-03
15,93	1,16E-04	22,75	2,34E-03
16,28	1,84E-04	23,25	2,49E-03
16,63	2,44E-04	23,75	3,11E-03
16,98	3,88E-04	24,25	3,20E-03
17,33	4,11E-04	24,75	3,53E-03
17,68	5,67E-04	25,25	4,17E-03
18,03	7,19E-04	25,75	4,61E-03
18,38	7,89E-04	26,25	5,05E-03
18,73	1,10E-03	26,75	5,50E-03
19,08	1,35E-03	27,25	5,98E-03
19,43	1,49E-03	27,75	6,31E-03
19,78	1,76E-03	28,25	6,64E-03
20,13	2,16E-03	28,75	6,97E-03
20,48	2,41E-03	29,25	7,58E-03
20,83	2,63E-03	29,75	7,61E-03
21,18	2,75E-03	30,25	7,94E-03
21,53	3,35E-03	30,75	8,31E-03
21,88	3,73E-03	31,25	8,63E-03
22,23	4,14E-03	31,75	8,83E-03
22,58	4,42E-03	32,25	9,05E-03

22,93	4,45E-03	32,75	9,32E-03
23,28	5,08E-03	33,25	9,68E-03
23,63	5,47E-03	33,75	9,63E-03
23,98	5,98E-03	34,25	9,94E-03
24,33	6,18E-03	34,75	1,00E-02
24,68	6,43E-03	35,25	1,05E-02
25,03	6,76E-03	35,75	1,02E-02
25,38	6,88E-03	36,25	1,03E-02
25,73	7,42E-03	36,75	1,05E-02
26,08	8,00E-03	37,25	1,08E-02
26,43	8,27E-03	37,75	1,08E-02
26,78	8,24E-03	38,25	1,09E-02
27,13	8,42E-03	38,75	1,09E-02
27,48	8,91E-03	39,25	1,13E-02
27,83	9,11E-03	39,75	1,09E-02
28,18	9,65E-03	40,25	1,09E-02
28,53	1,00E-02	40,75	1,11E-02
28,88	9,96E-03	41,25	1,10E-02
29,23	9,74E-03	41,75	1,11E-02
29,58	1,03E-02	42,25	1,10E-02
29,93	1,04E-02	42,75	1,09E-02
30,28	1,05E-02	43,25	1,10E-02
30,63	1,06E-02	43,75	1,09E-02
30,98	1,06E-02	44,25	1,08E-02
31,33	1,08E-02	44,75	1,07E-02
31,68	1,10E-02	45,25	1,06E-02
32,03	1,10E-02	45,75	1,06E-02
32,38	1,11E-02	46,25	1,04E-02
32,73	1,12E-02	46,75	1,08E-02
33,08	1,13E-02	47,25	1,06E-02
33,43	1,17E-02	47,75	1,03E-02
33,78	1,16E-02	48,25	1,03E-02
34,13	1,17E-02	48,75	1,02E-02
34,48	1,13E-02	49,25	9,76E-03
34,83	1,11E-02	49,75	1,03E-02
35,18	1,13E-02	50,25	9,73E-03
35,53	1,13E-02	50,75	9,84E-03
35,88	1,14E-02	51,25	9,59E-03
36,23	1,19E-02	51,75	9,56E-03
36,58	1,12E-02	52,25	9,33E-03
36,93	1,13E-02	52,75	9,19E-03

37,28	1,12E-02	53,25	9,27E-03
37,63	1,13E-02	53,75	9,14E-03
37,98	1,15E-02	54,25	8,97E-03
38,33	1,13E-02	54,75	9,11E-03
38,68	1,09E-02	55,25	9,01E-03
39,03	1,08E-02	55,75	8,84E-03
39,38	1,08E-02	56,25	8,79E-03
39,73	1,10E-02	56,75	8,81E-03
40,08	1,06E-02	57,25	8,73E-03
40,43	1,07E-02	57,75	2,42E-02
40,78	1,08E-02	58,25	8,25E-03
41,13	1,04E-02	58,75	8,18E-03
41,48	1,02E-02	59,25	3,55E-02
41,83	1,02E-02	59,75	7,79E-03
42,18	1,01E-02	60,25	7,85E-03
42,53	1,04E-02	60,75	7,54E-03
42,88	1,02E-02	61,25	7,45E-03
43,23	1,01E-02	61,75	7,27E-03
43,58	9,90E-03	62,25	7,31E-03
43,93	9,77E-03	62,75	7,01E-03
44,28	9,59E-03	63,25	7,01E-03
44,63	9,66E-03	63,75	7,05E-03
44,98	9,01E-03	64,25	6,77E-03
45,33	9,69E-03	64,75	6,59E-03
45,68	9,27E-03	65,25	6,56E-03
46,03	9,01E-03	65,75	6,50E-03
46,38	8,69E-03	66,25	6,32E-03
46,73	8,87E-03	66,75	9,19E-03
47,08	8,54E-03	67,25	1,31E-02
47,43	8,52E-03	67,75	6,08E-03
47,78	8,60E-03	68,25	5,88E-03
48,13	8,01E-03	68,75	5,79E-03
48,48	8,01E-03	69,25	8,28E-03
48,83	7,94E-03	69,75	4,69E-03
49,18	7,72E-03	70,25	4,66E-03
49,53	7,80E-03	70,75	4,52E-03
49,88	7,49E-03	71,25	4,45E-03
50,23	7,80E-03	71,75	4,30E-03
50,58	7,28E-03	72,25	4,23E-03
50,93	7,13E-03	72,75	4,16E-03
51,28	7,24E-03	73,25	4,14E-03

51,63	6,93E-03	73,75	3,88E-03
51,98	6,58E-03	74,25	3,82E-03
52,33	6,41E-03	74,75	4,01E-03
52,68	6,50E-03	75,25	3,71E-03
53,03	6,52E-03	75,75	3,68E-03
53,38	6,17E-03	76,25	3,60E-03
53,73	6,15E-03	76,75	3,61E-03
54,08	6,06E-03	77,25	3,65E-03
54,43	5,90E-03	77,75	3,42E-03
54,78	5,57E-03	78,25	3,28E-03
55,13	5,59E-03	78,75	3,23E-03
55,48	5,62E-03	79,25	3,21E-03
55,83	5,39E-03	79,75	3,10E-03
56,18	5,40E-03	80,25	3,07E-03
56,53	4,98E-03	80,75	2,97E-03
56,88	4,96E-03	81,25	2,84E-03
57,23	4,67E-03	81,75	2,79E-03
57,58	4,81E-03	82,25	2,67E-03
57,93	4,65E-03	82,75	2,67E-03
58,28	4,41E-03	83,25	2,48E-03
58,63	4,33E-03	83,75	2,51E-03
58,98	4,18E-03	84,25	2,50E-03
59,33	4,15E-03	84,75	2,34E-03
59,68	3,95E-03	85,25	2,35E-03
60,03	3,96E-03	85,75	2,16E-03
60,38	3,75E-03	86,25	2,13E-03
60,73	3,52E-03	86,75	2,07E-03
61,08	3,39E-03	87,25	2,03E-03
61,43	3,24E-03	87,75	1,89E-03
61,78	3,26E-03	88,25	1,86E-03
62,13	3,10E-03	88,75	1,79E-03
62,48	2,98E-03	89,25	1,62E-03
62,83	2,93E-03	89,75	1,67E-03
63,18	2,75E-03	90,25	1,60E-03
63,53	2,53E-03	90,75	1,43E-03
63,88	2,46E-03	91,25	1,38E-03
64,23	2,25E-03	91,75	1,28E-03
64,58	2,11E-03	92,25	1,23E-03
64,93	1,97E-03	92,75	1,14E-03
65,28	1,85E-03	93,25	1,03E-03
65,63	1,83E-03	93,75	1,04E-03

65,98	1,58E-03	94,25	9,20E-04
66,33	1,43E-03	94,75	8,11E-04
66,68	1,24E-03	95,25	7,85E-04
67,03	1,19E-03	95,75	6,62E-04
67,38	1,00E-03	96,25	5,96E-04
67,73	9,04E-04	96,75	5,09E-04
68,08	7,72E-04	97,25	4,39E-04
68,43	5,51E-04	97,75	3,66E-04
68,78	5,33E-04	98,25	2,70E-04
69,13	3,36E-04	98,75	1,93E-04
69,48	1,89E-04	99,25	1,12E-04
69,83	5,22E-05	99,75	3,84E-05

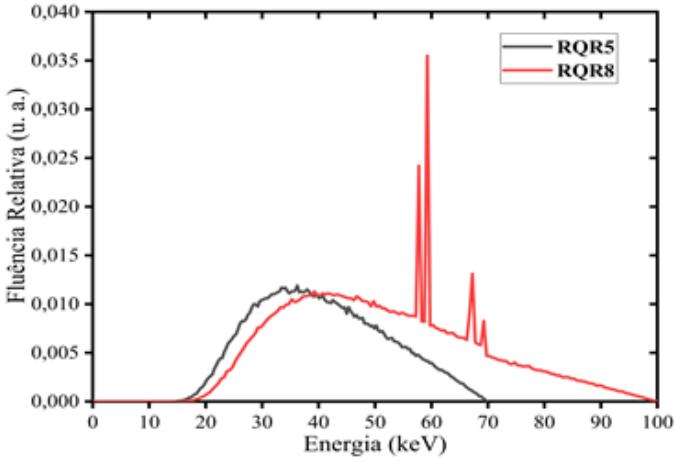

Figura 2 - Espectros dos feixes RQR 5 e RQR 8 simulados no *BEAMnrc.*