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Patient-specific in-vivo QA in MRGRT: 3D EPID dosimetry for the Unity MR-linac

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REFERENCES

1. Sandoiu A. MedicalNewsToday. <https://www.medicalnewstoday.com/articles/323677.php>.
2. Baskar R, Dai J, Wenlong N, Yeo R, Yeoh K-W. Biological response of cancer cells to radiation treatment. *Front Mol Biosci*. 2014;1(November):1-9. doi:10.3389/fmolb.2014.00024
3. Colgan R, McClelland J, McQuaid D, et al. Planning lung radiotherapy using 4D {CT} data and a motion model. *Phys Med Biol*. 2008;53(20):5815-5830. doi:10.1088/0031-9155/53/20/017
4. Differding S, Hanin F-X, Grégoire V. PET imaging biomarkers in head and neck cancer. *Eur J Nucl Med Mol Imaging*. 2015;42(4):613-622. doi:10.1007/s00259-014-2972-7
5. Sergieva S, Mihailova I, Zahariev Z, Dimcheva M, Bozhikov S. Role of SPECT-CT in radiotherapy. *J BUON*. 2014;19(3):831-835.
6. van der Meer S, Bloemen-van Gurp E, Hermans J, et al. Critical assessment of intramodality 3D ultrasound imaging for prostate IGRT compared to fiducial markers. *Med Phys*. 2013;40(7):71707. doi:10.1118/1.4808359
7. Groenendaal G, Moman MR, Korpelaar JG, et al. Validation of functional imaging with pathology for tumor delineation in the prostate. *Radiother Oncol*. 2010;94(2):145-150. doi:10.1016/j.radonc.2009.12.034
8. Bentzen SM. Theragnostic imaging for radiation oncology: Dose-painting by numbers. *Lancet Oncol*. 2005;6(2):112-117. doi:10.1016/S1470-2045(05)01737-7
9. van der Heide UA, Houweling AC, Groenendaal G, Beets-Tan RGH, Lambin P. Functional MRI for radiotherapy dose painting. *Magn Reson Imaging*. 2012;30(9):1216-1223. doi:<https://doi.org/10.1016/j.mri.2012.04.010>
10. Even AJG, Van Der Stoep J, Zegers CML, et al. PET-based dose painting in non-small cell lung cancer: Comparing uniform dose escalation with boosting hypoxic and metabolically active sub-volumes. *Radiother Oncol*. 2015;116(2):281-286. doi:10.1016/j.radonc.2015.07.013

11. Harat M, Małkowski B, Makarewicz R. Pre-irradiation tumour volumes defined by MRI and dual time-point FET-PET for the prediction of glioblastoma multiforme recurrence: A prospective study. *Radiother Oncol.* 2016;120(2):241-247. doi:10.1016/j.radonc.2016.06.004
12. Uzan J, Nahum AE, Syndikus I. Prostate Dose-painting Radiotherapy and Radiobiological Guided Optimisation Enhances the Therapeutic Ratio. *Clin Oncol.* 2016;28(3):165-170. doi:10.1016/j.clon.2015.09.006
13. Zamboglou C, Sachpazidis I, Koubar K, et al. Evaluation of intensity modulated radiation therapy dose painting for localized prostate cancer using 68Ga-HBED-CC PSMA-PET/CT: A planning study based on histopathology reference. *Radiother Oncol.* 2017;123(3):472-477. doi:10.1016/j.radonc.2017.04.021
14. BOGDANICH W. As Technology Surges, Radiation Safeguards Lag. *New York Times.*
15. BOGDANICH W. Radiation Offers New Cures, and Ways to Do Harm. *New York Times.*
16. Times T. Case Studies : When Medical Radiation Goes Awry. *New York Times.* <https://www.nytimes.com/2010/01/27/us/27RADIATIONSIDEBAR.html>. Published 2010.
17. Williams M V. Improving patient safety in radiotherapy by learning from near misses, incidents and errors. *Br J Radiol.* 2007;80(953):297-301. doi:10.1259/bjr/29018029
18. Derreumaux S. Lessons From Recent Accidents in. 2008;131(January):130-135.
19. Asnaashar K, Gholami S, Khosravi HR. Lessons learnt from errors in radiotherapy centers. *Iran J Radiat Res.* 2014;12(4):361-367. <http://www.scopus.com/inward/record.url?eid=2-s2.0-84920135613&partnerID=tZOtx3y1>
20. Das P, Johnson J, Hayden SE, et al. Rate of Radiation Therapy Events in a Large Academic Institution. *J Am Coll Radiol.* 2013;10(6):452-455. doi:https://doi.org/10.1016/j.jacr.2012.12.010

21. Spraker MB, Fain R, Gopan O, et al. Evaluation of near-miss and adverse events in radiation oncology using a comprehensive causal factor taxonomy. *Pract Radiat Oncol.* 2017;7(5):346-353. doi:10.1016/j.prro.2017.05.008
22. Ford EC, Evans SB. Incident learning in radiation oncology: A review. *Med Phys.* 2018;45(5):e100-e119. doi:10.1002/mp.12800
23. McKenzie EM, Balter PA, Stingo FC, Jones J, Followill DS, Kry SF. Toward optimizing patient-specific IMRT QA techniques in the accurate detection of dosimetrically acceptable and unacceptable patient plans. *Med Phys.* 2014;41(12):1-15. doi:10.1118/1.4899177
24. van Elmpt W, Nijsten S, Mijnheer B, Dekker A, Lambin P. The next step in patient-specific QA: 3D dose verification of conformal and intensity-modulated RT based on EPID dosimetry and Monte Carlo dose calculations. *Radiother Oncol.* 2008;86(1):86-92. doi:10.1016/j.radonc.2007.11.007
25. Agazaryan N. Patient specific quality assurance for the delivery of intensity modulated radiotherapy. *J Appl Clin Med Phys.* 2003;4(1):40. doi:10.1120/1.1525243
26. Ramachandran P, Tajaldeen A, Taylor D, Wanigaratne D, Roozen K, Geso M. Evaluation and Performance of ArcCheck and Film using Gamma Criteria in Pre-treatment Quality Assurance of Stereotactic Ablative Radiotherapy. *J Med Phys.* 2017;42(4):251-257. doi:10.4103/jmp.JMP_132_16
27. Blackwell CR, Coursey BM, Gall KP, et al. Radiochromic Film Dosimetry: Recommendations of AAPM Radiation Therapy Task Group 55. *Med Phys.* 1998;25(63):2093-2115.
28. Borca VC, Pasquino M, Russo G, et al. Dosimetric characterization and use of GAFCHROMIC EBT3 film for IMRT dose verification. *J Appl Clin Med Phys.* 2013;14(2):158-171. doi:10.1120/jacmp.v14i2.4111
29. Ulya S, Wibowo WE, Nuruddin N, Pawiro SA. Dosimetric Characteristics of EBT3 Gafchromic Film on Small Field

- Electron. AIP J. 2016;(2016):8-13.
30. Devic S. Radiochromic film dosimetry: Past, present, and future. *Phys Medica*. 2011;27(3):122-134. doi:10.1016/j.ejmp.2010.10.001
 31. Fuss M, Sturtewagen E, Wagter C De, Georg D. Dosimetric characterization of {GafChromic} {EBT} film and its implication on film dosimetry quality assurance. *Phys Med Biol*. 2007;52(14):4211-4225. doi:10.1088/0031-9155/52/14/013
 32. Banci Buonamici F, Compagnucci A, Marrazzo L, Russo S, Bucciolini M. An intercomparison between film dosimetry and diode matrix for IMRT quality assurance. *Med Phys*. 2007;34(4):1372-1379. doi:10.1118/1.2713426
 33. Lee PC, Sawicka JM, Glasgow GP. Patient dosimetry quality assurance program with a commercial diode system. *Int J Radiat Oncol*. 1994;29(5):1175-1182. doi:https://doi.org/10.1016/0360-3016(94)90415-4
 34. Esch A Van, Clermont C, Devillers M, Iori M, Huyskens DP. On-line quality assurance of rotational radiotherapy treatment delivery by means of a 2D ion chamber array and the Octavius phantom. *Med Phys*. 2007;34(10):3825-3837. doi:10.1118/1.2777006
 35. O'Daniel J, Das S, Wu QJ, Yin FF. Volumetric-modulated arc therapy: Effective and efficient end-to-end patient-specific quality assurance. *Int J Radiat Oncol Biol Phys*. 2012;82(5):1567-1574. doi:10.1016/j.ijrobp.2011.01.018
 36. Poppe B, Blechschmidt A, Djouguela A, et al. Two-dimensional ionization chamber arrays for IMRT plan verification. *Med Phys*. 2006;33(4):1005-1015. doi:10.1118/1.2179167
 37. Spezi E, Angelini AL, Romani F, Ferri A. Characterization of a 2D ion chamber array for the verification of radiotherapy treatments. *Phys Med Biol*. 2005;50(14):3361-3373. doi:10.1088/0031-9155/50/14/012
 38. Bouchard H, Seuntjens J. Ionization chamber-based reference dosimetry of intensity modulated radiation beams. *Med Phys*. 2004;31(9):2454-2465. doi:10.1118/1.1781333

39. Almond PR, Svensson H. Ionization chamber dosimetry for photon and electron beams. *Acta Oncol (Madr)*. 1977;16(2):177-186. doi:10.3109/02841867709134310
40. De Deene Y, De Wagter C, Van Duyse B, Derycke S, De Neve W, Achten E. Three-dimensional dosimetry using polymer gel and magnetic resonance imaging applied to the verification of conformal radiation therapy in head- and-neck cancer. *Radiother Oncol*. 1998;48(3):283-291. doi:10.1016/S0167-8140(98)00087-5
41. Gustavsson H, Karlsson A, Bäck SÅJ, et al. MAGIC-type polymer gel for three-dimensional dosimetry: Intensity-modulated radiation therapy verification. *Med Phys*. 2003;30(6):1264-1271. doi:10.1118/1.1576392
42. Vergote K, Deene Y De, Duthoy W, et al. Validation and application of polymer gel dosimetry for the dose verification of an intensity-modulated arc therapy (IMAT) treatment. *Phys Med Biol*. 2004;49(2):287-305. doi:10.1088/0031-9155/49/2/008
43. Low DA, Dempsey JF, Venkatesan R, et al. Evaluation of polymer gels and MRI as a 3-D dosimeter for intensity-modulated radiation therapy. *Med Phys*. 1999;26(8):1542-1551. doi:10.1118/1.598650
44. van Herk M, Meertens H. A matrix ionisation chamber imaging device for on-line patient setup verification during radiotherapy. *Radiother Oncol*. 1988;11(4):369-378. doi:https://doi.org/10.1016/0167-8140(88)90208-3
45. Meertens H, van Herk M, Bijhold J, Bartelink H. First clinical experience with a newly developed electronic portal imaging device. *Int J Radiat Oncol*. 1990;18(5):1173-1181. doi:https://doi.org/10.1016/0360-3016(90)90455-S
46. Essers M, Hoogervorst BR, van Herk M, Lanson H, Mijnheer BJ. Dosimetric characteristics of a liquid-filled electronic portal imaging device. *Int J Radiat Oncol Biol Phys*. 1995;33(5):1265-1272. doi:10.1016/0360-3016(95)00108-5
47. Korevaar EW, Wauben DJL, van der Hulst PC, Langendijk JA,

- van't Veld AA. Clinical introduction of a linac head-mounted 2D detector array based quality assurance system in head and neck IMRT. *Radiother Oncol.* 2011;100(3):446-452. doi:<https://doi.org/10.1016/j.radonc.2011.09.007>
48. Alrowaili ZA, Lerch MLF, Carolan M, et al. 2D mapping of the {MV} photon fluence and 3D dose reconstruction in real time for quality assurance during radiotherapy treatment. *J Instrum.* 2015;10(09):P09019--P09019. doi:10.1088/1748-0221/10/09/p09019
 49. Litzenberg DW, Moran JM, Fraass BA. Verification of dynamic and segmental IMRT delivery by dynamic log file analysis. *J Appl Clin Med Phys.* 2002;3(2):63-72. doi:10.1120/jacmp.v3i2.2578
 50. Qian J, Lee L, Liu W, et al. Dose reconstruction for volumetric modulated arc therapy (VMAT) using cone-beam CT and dynamic log files. *Phys Med Biol.* 2010;55(13):3597-3610. doi:10.1088/0031-9155/55/13/002
 51. Mans A, Wendling M, McDermott LN, et al. Catching errors with in vivo EPID dosimetry. *Med Phys.* 2010;37(6):2638-2644. doi:10.1118/1.3397807
 52. Ford EC, Terezakis S, Souranis A, Harris K, Gay H, Mutic S. Quality control quantification (QCCQ): A tool to measure the value of quality control checks in radiation oncology. *Int J Radiat Oncol Biol Phys.* 2012;84(3):e263-e269. doi:10.1016/j.ijrobp.2012.04.036
 53. Piermattei A, Fidanzio A, Stimato G, et al. In vivo dosimetry by an aSi-based EPID. *Med Phys.* 2006;33(11):4414-4422. doi:10.1118/1.2360014
 54. Piermattei A, Fidanzio A, Azario L, et al. In patient dose reconstruction using a cine acquisition for dynamic arc radiation therapy. *Med Biol Eng Comput.* 2009;47(4):425-433. doi:10.1007/s11517-009-0456-x
 55. Chytyk K, Mccurdy BMC. Comprehensive fluence model for absolute portal dose image prediction. *Med Phys.* 2009;36(4):1389-1398. doi:10.1118/1.3083583

56. Chytyk-Praznik K, Vanuytven E, Vanbeek TA, Greer PB, McCurdy BMC. Model-based prediction of portal dose images during patient treatment. *Med Phys.* 2013;40(3). doi:10.1118/1.4792203
57. Bedford JL, Hanson IM, Hansen VN. Portal dosimetry for VMAT using integrated images obtained during treatment. *Med Phys.* 2014;41(2). doi:10.1118/1.4862515
58. Wendling M, McDermott LN, Mans A, Sonke J-J, van Herk M, Mijnheer BJ. A simple backprojection algorithm for 3D in vivo EPID dosimetry of IMRT treatments. *Med Phys.* 2009;36(7):3310-3321. doi:10.1118/1.3148482
59. Mans A, Remeijer P, Olaciregui-Ruiz I, et al. 3D Dosimetric verification of volumetric-modulated arc therapy by portal dosimetry. *Radiother Oncol.* 2010;94(2):181-187. doi:10.1016/j.radonc.2009.12.020
60. van Elmpt W, Nijsten S, Petit S, Mijnheer B, Lambin P, Dekker A. 3D In Vivo Dosimetry Using Megavoltage Cone-Beam CT and EPID Dosimetry. *Int J Radiat Oncol Biol Phys.* 2009;73(5):1580-1587. doi:10.1016/j.ijrobp.2008.11.051
61. van Elmpt W, Petit S, De Ruyscher D, Lambin P, Dekker A. 3D dose delivery verification using repeated cone-beam imaging and EPID dosimetry for stereotactic body radiotherapy of non-small cell lung cancer. *Radiother Oncol.* 2010;94(2):188-194. doi:10.1016/j.radonc.2009.12.024
62. Scalchi P, Francescon P. Calibration of a MOSFET detection system for 6-MV in vivo dosimetry. *Int J Radiat Oncol Biol Phys.* 1998;40(4):987-993. doi:10.1016/S0360-3016(97)00894-8
63. Halvorsen PH. Dosimetric evaluation of a new design MOSFET in vivo dosimeter. *Med Phys.* 2005;32(1):110-117. doi:10.1118/1.1827771
64. Higgins PD, Alaei P, Gerbi BJ, Dusenbery KE. In vivo diode dosimetry for routine quality assurance in IMRT. *Med Phys.* 2003;30(12):3118-3123. doi:10.1118/1.1626989
65. Kirby MC, Williams PC. The use of an electronic portal imaging

- device for exit dosimetry and quality control measurements. *Int J Radiat Oncol.* 1995;31(3):593-603. doi:[https://doi.org/10.1016/0360-3016\(94\)00388-2](https://doi.org/10.1016/0360-3016(94)00388-2)
66. Essers M, Lanson JH, Leunens G, Schnabel T, Mijnheer BJ. The accuracy of CT-based inhomogeneity corrections and in vivo dosimetry for the treatment of lung cancer. *Radiother Oncol.* 1995;37(3):199-208. doi:[https://doi.org/10.1016/0167-8140\(95\)01659-7](https://doi.org/10.1016/0167-8140(95)01659-7)
 67. Boellaard R, Van Herk M, Uiterwaal H, Mijnheer B. Two-dimensional exit dosimetry using a liquid-filled electronic portal imaging device and a convolution model. *Radiother Oncol.* 1997;44(2):149-157. doi:[10.1016/S0167-8140\(97\)00073-X](https://doi.org/10.1016/S0167-8140(97)00073-X)
 68. Kroonwijk M, Pasma KL, Quint S, Koper PCM, Visser AG, Heijmen BJM. In vivo dosimetry for prostate cancer patients using an electronic portal imaging device (EPID); demonstration of internal organ motion. *Radiother Oncol.* 1998;49(2):125-132. doi:[10.1016/S0167-8140\(98\)00122-4](https://doi.org/10.1016/S0167-8140(98)00122-4)
 69. Van Uytven E, Van Beek T, McCowan PM, Chytyk-Praznik K, Greer PB, McCurdy BMC. Validation of a method for in vivo 3D dose reconstruction for IMRT and VMAT treatments using on-treatment EPID images and a model-based forward-calculation algorithm. *Med Phys.* 2015;42(12):6945-6954. doi:[10.1118/1.4935199](https://doi.org/10.1118/1.4935199)
 70. Wendling M, Louwe RJW, McDermott LN, Sonke J-J, van Herk M, Mijnheer BJ. Accurate two-dimensional IMRT verification using a back-projection EPID dosimetry method. *Med Phys.* 2006;33(2):259-273. doi:[10.1118/1.2147744](https://doi.org/10.1118/1.2147744)
 71. Method NEW, Obtain TO, Midplane THE, Using D, Dosimetry INV. New Method To Obtain the Midplane Dose Using Portal. *Radiat Oncol.* 1998;41(2):465-474.
 72. Dosisoft epigray. <https://www.dosisoft.com/patient-qa/in-vivo-epigray.html>
 73. SunNuclear PerFraction. <http://www.sunnuclear.com/solutions/>

patientqa/perfraction

74. IBA OmniPro-InViDos. <http://www.iba-dosimetry.com/complete-solutions/radiotherapy/in-vivo-dosimetry/omnipro-invidos>
75. Elekta iViewDose. <https://www.elekta.com/radiotherapy/treatment-solutions/quality-assurance/iviewdose>
76. Vazquez-Quino LA, Huerta-Hernandez CI, Rangaraj D. Clinical experience with machine log file software for volumetric-modulated arc therapy techniques. *Baylor Univ Med Cent Proc.* 2017;30(3):276-279. doi:10.1080/08998280.2017.11929614
77. Teke T, Bergman AM, Kwa W, Gill B, Duzenli C, Popescu IA. Monte Carlo based, patient-specific RapidArc QA using Linac log files. *Med Phys.* 2010;37(1):116-123. doi:10.1118/1.3266821
78. Stell AM, Li JG, Zeidan OA, Dempsey JF. An extensive log-file analysis of step-and-shoot intensity modulated radiation therapy segment delivery errors. *Med Phys.* 2004;31(6):1593-1602. doi:10.1118/1.1751011
79. Lee L, Le QT, Xing L. Retrospective IMRT Dose Reconstruction Based on Cone-Beam CT and MLC Log-File. *Int J Radiat Oncol Biol Phys.* 2008;70(2):634-644. doi:10.1016/j.ijrobp.2007.09.054
80. Liu S, Mazur TR, Li H, et al. A method to reconstruct and apply 3D primary fluence for treatment delivery verification. *J Appl Clin Med Phys.* 2017;18(1):128-138. doi:10.1002/acm2.12017
81. Barbeiro AR, Ureba A, Baeza JA, et al. 3D VMAT verification based on monte carlo log file simulation with experimental feedback from film dosimetry. *PLoS One.* 2016;11(11):1-19. doi:10.1371/journal.pone.0166767
82. Low DA, Harms WB, Mutic S, Purdy J a. A technique for the quantitative evaluation of dose distributions. *Med Phys.* 1998;25(5):656-661. doi:10.1118/1.598248
83. Szczurek L, Juszkat R, Szczurek J, Turek I, Sosnowski P. Pre-treatment 2D and 3D dosimetric verification of volumetric arc

- therapy. A correlation study between gamma index passing rate and clinical dose volume histogram. *PLoS One*. 2019;14(8):1-17. doi:10.1371/journal.pone.0221086
84. van der Bijl E, van Oers RFM, Olaciregui-Ruiz I, Mans A. Comparison of gamma- and DVH-based in vivo dosimetric plan evaluation for pelvic VMAT treatments. *Radiother Oncol*. 2017;125(3):405-410. doi:10.1016/j.radonc.2017.09.014
 85. McDermott LN, Wendling M, Nijkamp J, et al. 3D in vivo dose verification of entire hypo-fractionated IMRT treatments using an EPID and cone-beam CT. *Radiother Oncol*. 2008;86(1):35-42. doi:10.1016/j.radonc.2007.11.010
 86. Wendling M, N. McDermott L, Mans A, et al. In aqua vivo EPID dosimetry. *Med Phys*. 2011;39(1):367-377. doi:10.1118/1.3665709
 87. Olaciregui-Ruiz I, Rozendaal R, Mijnheer B, Van Herk M, Mans A. Automatic in vivo portal dosimetry of all treatments. *Phys Med Biol*. 2013;58(22):8253-8264. doi:10.1088/0031-9155/58/22/8253
 88. Olaciregui-Ruiz I, Rozendaal R, van Oers RFM, Mijnheer B, Mans A. Virtual patient 3D dose reconstruction using in air EPID measurements and a back-projection algorithm for IMRT and VMAT treatments. *Phys Medica*. 2017;37:49-57. doi:10.1016/j.ejmp.2017.04.016
 89. Spreeuw H, Rozendaal R, Olaciregui-Ruiz I, et al. Online 3D EPID-based dose verification: Proof of concept. *Med Phys*. 2016;43(7):3969-3974. doi:10.1118/1.4952729
 90. Mijnheer BJ, González P, Olaciregui-Ruiz I, Rozendaal RA, van Herk M, Mans A. Overview of 3-year experience with large-scale electronic portal imaging device-based 3-dimensional transit dosimetry. *Pract Radiat Oncol*. 2015;5(6):e679-e687. doi:10.1016/j.prro.2015.07.001
 91. Raaijmakers a JE, Raaymakers BW, Lagendijk JJW. Integrating a MRI scanner with a 6 MV radiotherapy accelerator: dose increase at tissue-air interfaces in a lateral magnetic field due to returning electrons. *Phys Med Biol*. 2005;50(7):1363-1376.

doi:10.1088/0031-9155/50/7/002

92. Lagendijk JJW, Raaymakers BW, van Vulpen M. The Magnetic Resonance Imaging-Linac System. *Semin Radiat Oncol.* 2014;24(3):207-209. doi:10.1016/j.semradonc.2014.02.009
93. Raaymakers BW, de Boer JCJ, Knox C, et al. Integrated megavoltage portal imaging with a 1.5 T MRI linac. *Phys Med Biol.* 2011;56(19):N207-N214. doi:10.1088/0031-9155/56/19/N01
94. Kupelian P, Sonke J. Magnetic Resonance – Guided Adaptive Radiotherapy: A Solution to the Future. *Semin Radiat Oncol.* 2014;24(3):227-232. doi:10.1016/j.semradonc.2014.02.013
95. Seregini M, Paganelli C, Summers P, Bellomi M, Baroni G, Riboldi M. A hybrid image registration and matching framework for real-time motion tracking in MRI-guided radiotherapy. *IEEE Trans Biomed Eng.* 2018;65(1):131-139. doi:10.1109/TBME.2017.2696361
96. Kashani R, Olsen JR. Magnetic Resonance Imaging for Target Delineation and Daily Treatment Modification. *Semin Radiat Oncol.* 2018;28(3):178-184. doi:10.1016/j.semradonc.2018.02.002
97. Houweling AC, De Vries JHW, Wolthaus J, et al. Performance of a cylindrical diode array for use in a 1.5 T MR-linac. *Phys Med Biol.* 2016;61(3):N80-N89. doi:10.1088/0031-9155/61/3/N80
98. Smit K, Kok JGM, Lagendijk JJW, Raaymakers BW. Performance of a multi-axis ionization chamber array in a 1.5 T magnetic field. *Phys Med Biol.* 2014;59(7):1845-1855. doi:10.1088/0031-9155/59/7/1845
99. De Vries JHW, Seravalli E, Houweling AC, et al. Characterization of a prototype MR-compatible Delta4 QA system in a 1.5 tesla MR-linac. *Phys Med Biol.* 2018;63(2). doi:10.1088/1361-6560/aa9d26
100. Lee HJ, Roed Y, Venkataraman S, Carroll M, Ibbott GS. Investigation of magnetic field effects on the dose-response of 3D dosimeters for magnetic resonance – image guided radiation therapy applications. *Radiother Oncol.* 2017;125(3):426-432.

doi:10.1016/j.radonc.2017.08.027

101. Kaas Jochem et al. A fast automated sanity check for online plan adaptation in MR-guided RT. In: ESTRO37. ; 2018:994.
102. Shafai-Erfani G, Wang T, Lei Y, et al. Dose evaluation of MRI-based synthetic CT generated using a machine learning method for prostate cancer radiotherapy. *Med Dosim.* 2019;(xxxx):12-16. doi:10.1016/j.meddos.2019.01.002
103. Pathmanathan AU, van As NJ, Kerkmeijer LGW, et al. Magnetic Resonance Imaging-Guided Adaptive Radiation Therapy: A “Game Changer” for Prostate Treatment? *Int J Radiat Oncol Biol Phys.* 2018;100(2):361-373. doi:10.1016/j.ijrobp.2017.10.020
104. Kemppainen R, Suilamo S, Tuokkola T, Lindholm P, Deppe MH, Keyriläinen J. Magnetic resonance-only simulation and dose calculation in external beam radiation therapy: a feasibility study for pelvic cancers. *Acta Oncol (Madr).* 2017;56(6):792-798. doi:10.1080/0284186X.2017.1293290
105. Neal B, Ahmed M, Kathuria K, et al. A clinically observed discrepancy between image-based and log-based MLC positions A clinically observed discrepancy between image-based and log-based MLC positions. *Med Phys.* 2016;43:2933. doi:10.1118/1.4949002
106. Mutic S, Dempsey JF. The ViewRay System : Magnetic Resonance -. *Semin Radiat Oncol.* 2014;24(3):196-199. doi:10.1016/j.semradonc.2014.02.008
107. Fallone BG, Murray B, Rathee S, et al. First MR images obtained during megavoltage photon irradiation from a prototype integrated linac-MR system. *Med Phys.* 2009;36(6):2084-2088. doi:10.1118/1.3182419
108. Fallone BG. The Rotating Biplanar Linac-Magnetic Resonance Imaging System. *Semin Radiat Oncol.* 2014;24(3):200-202. doi:10.1016/j.semradonc.2014.02.011
109. Keall PJ, Barton M, Crozier S. The Australian Magnetic Resonance Imaging-Linac Program. *Semin Radiat Oncol.*

- 2014;24(3):203-206. doi:10.1016/j.semradonc.2014.02.015
110. Heid O, Kleemann M, Heller J. Integrated MRI-LINAC Radiotherapy Machine. *Proc Intl Soc Mag Reson Med*. 2015;23(1):3068.
 111. Grein EE, Lee R, Luchka K. An investigation of a new amorphous silicon electronic portal imaging device for transit dosimetry. *Med Phys*. 2002;29(10):2262-2268. doi:10.1118/1.1508108
 112. Warkentin B, Steciw S, Rathee S FB. Dosimetric IMRT verification with a flat-panel EPID. *Med Phys*. 2003;30(12):3143-3155. doi:10.1118/1.1843471
 113. Greer PB, Popescu CC. Dosimetric properties of an amorphous silicon electronic portal imaging device for verification of dynamic intensity modulated radiation therapy. *Med Phys*. 2003;30(7):1618-1627. doi:10.1118/1.1582469
 114. McDermott LN, Louwe RJW, Sonke JJ, van Herk MB, Mijnheer BJ. Dose-response and ghosting effects of an amorphous silicon electronic portal imaging device. *Med Phys*. 2004;31(2):285-295. doi:10.1118/1.1637969
 115. Elmpt W Van, McDermott L, Nijsten S, Wendling M, Lambin P, Mijnheer B. A literature review of electronic portal imaging for radiotherapy dosimetry. *Radiother Oncol*. 2008;88:289-309. doi:10.1016/j.radonc.2008.07.008
 116. Mijnheer BJ, Gonzalez P, Olaciregui-Ruiz I, Rozendaal RA, van Herk M MA. Overview of 3-year experience with large-scale electronic portal imaging device-based 3-dimensional transit dosimetry. *Pr Radiat Oncol*. 2015;Dec 5(6):e679-87.
 117. Raaijmakers a JE, Raaymakers BW, Lagendijk JJW. Experimental verification of magnetic field dose effects for the MRI-accelerator. *Phys Med Biol*. 2007;52(14):4283-4291. doi:10.1088/0031-9155/52/14/017
 118. Essers M, Hoogervorst BR, van Herk M, Lanson H, Mijnheer BJ. Dosimetric characteristics of a liquid-filled electronic portal imaging device. *Int J Radiat Oncol Biol Phys*. 1995;33(5):1265-

1272. doi:10.1016/0360-3016(95)00108-5
119. Louwe RJW, McDermott LN, Sonke JJ, et al. The long-term stability of amorphous silicon flat panel imaging devices for dosimetry purposes. *Med Phys.* 2004;31(11):2989-2995. doi:10.1118/1.1803751
 120. Swindell W, Evans PM. Scattered radiation in portal images: a Monte Carlo simulation and a simple physical model. *Med Phys.* 1996;23(1):63-73. doi:10.1118/1.597792
 121. Hansen VN, Swindell W, Evans PM. Extraction of primary signal from EPIDs using only forward convolution. *Med Phys.* 1997;24(9):1477-1484. doi:10.1118/1.598036
 122. Spies L, Partridge M, Groh B a, Bortfeld T. An iterative algorithm for reconstructing incident beam distributions from transmission measurements using electronic portal imaging. *Phys Med Biol.* 2001;46(8):N203-N211. doi:10.1088/0031-9155/46/8/402
 123. Chuter RW, Rixham PA, Weston SJ, Cosgrove VP. Feasibility of portal dosimetry for flattening filter-free radiotherapy. *J Appl Clin Med Phys.* 2016;17(1):112-120. doi:10.1120/jacmp.v17i1.5686
 124. K Smit, DA Roberts, JGM Kok JL and BR. The impact of beam transmission through a closed bore MRI on several beam characteristics for a prototype MR-linac system. *Manuscr Prep Submiss.* Published online 2015.
 125. Court L. MRI Guided Radiotherapy: Integration of a Philips MRI scanner with an Elekta Linac.
 126. Raaymakers BW, Lagendijk JJW, Overweg J, et al. Integrating a 1.5 T MRI scanner with a 6 MV accelerator: proof of concept. *Phys Med Biol.* 2009;54(12):N229-N237. doi:10.1088/0031-9155/54/12/N01
 127. Liu B, Adamson J, Rodrigues A, Zhou F. A novel technique for VMAT QA with EPID in cine mode on a Varian TrueBeam linac A novel technique for VMAT QA with EPID in cine mode on a Varian TrueBeam linac. Published online 2013. doi:10.1088/0031-

9155/58/19/6683

128. Woodruff HC, Fuangrod T, Rowshanfarzad P, Mccurdy BMC, Greer PB, Greer PB. Gantry-angle resolved VMAT pretreatment verification using EPID image prediction Gantry-angle resolved VMAT pretreatment verification using EPID. 2014;081715(2013). doi:10.1118/1.4816384
129. Han B, Ding A, Lu M, Xing L. Pixel response-based EPID dosimetry for patient specific QA. 2017;(May 2016):9-17. doi:10.1002/acm2.12007
130. van Zijtveld M, Dirkx MLP, de Boer HCJ, Heijmen BJM. Dosimetric pre-treatment verification of IMRT using an EPID; clinical experience. *Radiother Oncol.* 2006;81(2):168-175. doi:10.1016/j.radonc.2006.09.008
131. Van Esch A, Depuydt T, Huyskens DP. The use of an aSi-based EPID for routine absolute dosimetric pre-treatment verification of dynamic IMRT fields. *Radiother Oncol.* 2004;71(2):223-234. doi:10.1016/j.radonc.2004.02.018
132. Herman MG. Clinical use of electronic portal imaging. *Semin Radiat Oncol.* 2005;15(3):157-167. doi:10.1016/j.semradonc.2005.01.002
133. Woodruff HC, Fuangrod T, Uytven E Van, et al. First Experience With Real-Time EPID-Based Delivery Verification During IMRT and VMAT Sessions. *Radiat Oncol Biol.* 2015;93(3):516-522. doi:10.1016/j.ijrobp.2015.07.2271
134. Reynolds M, Fallone BG, Rathee S. Dose response of selected ion chambers in applied homogeneous transverse and longitudinal magnetic fields. *Med Phys.* 2013;40(4):042102. doi:10.1118/1.4794496
135. Smit K, van Asselen B, Kok JGM, Aalbers HL, Lagendijk JJW, Raaymakers BW. Towards reference dosimetry for the MR-linac: magnetic field correction of the ionization chamber reading. *Phys Med Biol.* 2013;58(17):5945-5957. doi:10.1088/0031-9155/58/17/5945

136. Raaijmakers a JE, Raaymakers BW, Lagendijk JJW. Magnetic-field-induced dose effects in MR-guided radiotherapy systems: dependence on the magnetic field strength. *Phys Med Biol.* 2008;53(4):909-923. doi:10.1088/0031-9155/53/4/006
137. McDermott LN, Nijsten SMJJG, Sonke J-J, Partridge M, van Herk M, Mijnheer BJ. Comparison of ghosting effects for three commercial a-Si EPIDs. *Med Phys.* 2006;33(7):2448-2451. doi:10.1118/1.2207318
138. Winkler P, Hefner A, Georg D. Dose-response characteristics of an amorphous silicon EPID. *Med Phys.* 2005;32(10):3095-3105. doi:10.1118/1.2040711
139. Torres-Xirau I, Olaciregui-Ruiz I, Rozendaal R, et al. A back-projection algorithm in the presence of an extra attenuating medium : towards EPID dosimetry for the MR-Linac. *Phys Med Biol.* 2017;62:6322-6340.
140. McCurdy BM, Luchka K, Pistorius S. Dosimetric investigation and portal dose image prediction using an amorphous silicon electronic portal imaging device. *Med Phys.* 2001;28(6):911-924. doi:10.1118/1.1374244
141. Greer PB. Correction of pixel sensitivity variation and off-axis response for amorphous silicon EPID dosimetry. *Med Phys.* 2005;32(12):3558-3568. doi:10.1118/1.2128498
142. Vial P, Gustafsson H, Oliver L, Baldock C, Greer PB. Direct-detection EPID dosimetry: Investigation of a potential clinical configuration for IMRT verification. *Phys Med Biol.* 2009;54(23):7151-7169. doi:10.1088/0031-9155/54/23/008
143. McCowan PM, McCurdy BMC. Frame average optimization of cine-mode EPID images used for routine clinical in vivo patient dose verification of VMAT deliveries. *Med Phys.* 2016;43(1):254-261. doi:10.1118/1.4938413
144. Nijsten SMJJG, Mijnheer BJ, Dekker ALAJ, Lambin P, Minken AWH. Routine individualised patient dosimetry using electronic portal imaging devices. *Radiother Oncol.* 2007;83(1):65-75.

doi:10.1016/j.radonc.2007.03.003

145. Nelms BE, Rasmussen KH, Tomé WA. Evaluation of a fast method of EPID-based dosimetry for intensity modulated radiation therapy. *J Appl Clin Med Phys*. 2011;11(2):1-28.
146. Berry SL, Polvorosa C, Cheng S, Deutsch I, Chao KSC, Wu CS. Initial clinical experience performing patient treatment verification with an electronic portal imaging device transit dosimeter. *Int J Radiat Oncol Biol Phys*. 2014;88(1):204-209. doi:10.1016/j.ijrobp.2013.09.045
147. Francois P, Boissard P, Berger L, Mazal A. In vivo dose verification from back projection of a transit dose measurement on the central axis of photon beams. *Phys Medica*. 2011;27(1):1-10. doi:10.1016/j.ejmp.2010.06.002
148. Van Uytven E, Van Beek T, McCowan PM, Chytky-Praznik K, Greer PB, McCurdy BMC. Validation of a method for in vivo 3D dose reconstruction for IMRT and VMAT treatments using on-treatment EPID images and a model-based forward-calculation algorithm. *Med Phys*. 2015;42(12):6945-6954. doi:10.1118/1.4935199
149. McCowan PM, Asuni G, Van Uytven E, et al. Clinical Implementation of a Model-Based In Vivo Dose Verification System for Stereotactic Body Radiation Therapy-Volumetric Modulated Arc Therapy Treatments Using the Electronic Portal Imaging Device. *Int J Radiat Oncol Biol Phys*. 2017;97(5):1077-1084. doi:10.1016/j.ijrobp.2017.01.227
150. Persoon LCGG, Podesta M, Nijsten SMJJG, Troost EGC, Verhaegen F. Time-Resolved Versus Integrated Transit Planar Dosimetry for Volumetric Modulated Arc Therapy: Patient-Specific Dose Differences During Treatment, a Proof of Principle. *Technol Cancer Res Treat*. 2016;15(6):NP79-NP87. doi:10.1177/1533034615617668
151. Raaijmakers AJE, Raaymakers BW, Lagendijk JJW, et al. Experimental verification of magnetic field dose effects for the MRI-accelerator. doi:10.1088/0031-9155/52/14/017

152. B W Raaymakers et al. First patients treated with a 1 . 5 T MRI-Linac : clinical proof of concept of a high-precision , high- field MRI guided radiotherapy treatment First patients treated with a 1 . 5 T MRI- Linac : clinical proof of concept of a high-precision , high-field M. Published online 2017.
153. Chen G, Ahunbay E, Li XA. Technical Note : Development and performance of a software tool for quality assurance of online replanning with a conventional Linac or MR-Linac.
154. Kontaxis C, Bol GH, Stemkens B, et al. Towards fast online intrafraction replanning for free-breathing stereotactic body radiation therapy with the MR-linac Towards fast online intrafraction replanning for free-breathing stereotactic body radiation therapy with the MR-linac.
155. Glitzner M, Crijns SPM, Denis De Senneville B, et al. On-line MR imaging for dose validation of abdominal radiotherapy. *Phys Med Biol.* 2015;60(22):8869-8883. doi:10.1088/0031-9155/60/22/8869
156. Torres-Xirau I, Olaciregui-Ruiz I, Baldvinsson G, Mijnheer BJ, Van Der Heide UA, Mans A. Characterization of the a-Si EPID in the unity MR-linac for dosimetric applications. *Phys Med Biol.* 2018;63(2). doi:10.1088/1361-6560/aa9dbf
157. Olaciregui-Ruiz I, Rozendaal R, Mijnheer B, A M. A 2D couch attenuation model for in vivo EPID transit dosimetry. *Biomed Phys Eng Express.* 2017;4(2):5027.
158. Louwe RJW, McDermott LN, Sonke J-J, et al. The long-term stability of amorphous silicon flat panel imaging devices for dosimetry purposes. *Med Phys.* 2004;31(11):2989-2995. doi:10.1118/1.1803751
159. Hackett S, van Asselen B, G F, et al. SU-F-J-148: A Collapsed Cone Algorithm Can Be Used for Quality Assurance for Monaco Treatment Plans for the MR-Linac. *Med Phys.* 2016;43(6Part11):3441. doi:10.1118/1.4956056
160. Chen GP, Ahunbay E, Li XA. Technical Note: Development and

- performance of a software tool for quality assurance of online replanning with a conventional Linac or MR-Linac. *Med Phys.* 2016;43(4):1713-1719. doi:10.1118/1.4943795
161. Rathee S, Fallone BG, Steciw S. Technical Note: <scp>EPID</scp>'s response to 6 <scp>MV</scp> photons in a strong, parallel magnetic field. *Med Phys.* Published online 2018:mp.13285. doi:10.1002/mp.13285
 162. Torres-Xirau I, Olaciregui-Ruiz I, van der Heide UA, Mans A. 2D <scp>EPID</scp> dosimetry for an <scp>MR</scp>-linac: proof of concept. *Med Phys.* Published online 2019:mp.13664. doi:10.1002/mp.13664
 163. Bol GH, Lagendijk JJW, Raaymakers BW. Virtual couch shift (VCS): Accounting for patient translation and rotation by online IMRT re-optimization. *Phys Med Biol.* 2013;58(9):2989-3000. doi:10.1088/0031-9155/58/9/2989
 164. Lagendijk JJW, Raaymakers BW, Van Den Berg CAT, Moerland MA, Philippens ME, Van Vulpen M. MR guidance in radiotherapy. *Phys Med Biol.* 2014;59(21):R349-R369. doi:10.1088/0031-9155/59/21/R349
 165. Kontaxis C, Bol GH, Stemkens B, et al. Towards fast online intrafraction replanning for free-breathing stereotactic body radiation therapy with the MR-linac. *Phys Med Biol.* Published online 2017. doi:10.1088/1361-6560/aa82ae
 166. Raaymakers BW, Jürgenliemk-Schulz IM, Bol GH, et al. First patients treated with a 1.5 T MRI-Linac: Clinical proof of concept of a high-precision, high-field MRI guided radiotherapy treatment. *Phys Med Biol.* 2017;62(23):L41-L50. doi:10.1088/1361-6560/aa9517
 167. Kupelian P, Sonke JJ. Magnetic Resonance-Guided Adaptive Radiotherapy: A Solution to the Future. *Semin Radiat Oncol.* 2014;24(3):227-232. doi:10.1016/j.semradonc.2014.02.013
 168. Vries JHW De, Seravalli E, Houweling AC, et al. Characterization of a prototype MR-compatible Characterization of a prototype

- MR-compatible Delta4 QA system in a 1 . 5 tesla MR-linac. Published online 2018.
169. Kaas J, Van den Wollenberg W, Van de Schoot AJAJ, Wittkämper FW, Janssen TM. PO-0994: A fast automated sanity check for online plan adaptation in MR-guided RT. *Radiother Oncol*. Published online 2018. doi:10.1016/s0167-8140(18)31304-5
 170. Bedford JL, Hanson IM, Hansen VN. Comparison of forward- and back-projection in vivo EPID dosimetry for VMAT treatment of the prostate. *Phys Med Biol*. 2018;63(2). doi:10.1088/1361-6560/aa9c60
 171. Celi S, Costa E, Wessels C, Mazal A, Fourquet A, Francois P. EPID based in vivo dosimetry system: Clinical experience and results. *J Appl Clin Med Phys*. 2016;17(3):262-276. doi:10.1120/jacmp.v17i3.6070
 172. Nailon WH, Welsh D, McDonald K, et al. <sc>EPID</sc> - based in vivo dosimetry using Dosimetry Check™: Overview and clinical experience in a 5-yr study including breast, lung, prostate, and head and neck cancer patients. *J Appl Clin Med Phys*. Published online 2018:acm2.12441. doi:10.1002/acm2.12441
 173. Cilla S, Ianiro A, Craus M, et al. Epid-based in vivo dose verification for lung stereotactic treatments delivered with multiple breath-hold segmented volumetric modulated arc therapy. *J Appl Clin Med Phys*. 2019;20(3):37-44. doi:10.1002/acm2.12538
 174. Bedford JL, Hanson IM, Hansen VN. Portal dosimetry for VMAT using integrated images obtained during treatment. *Med Phys*. 2014;41(2). doi:10.1118/1.4862515
 175. Persoon LCGG, Nijsten SMJJG, Wilbrink FJ, et al. Interfractional trend analysis of dose differences based on 2D transit portal dosimetry. *Phys Med Biol*. 2012;57(20):6445-6458. doi:10.1088/0031-9155/57/20/6445
 176. Mans A, Remeijer P, Olaciregui-Ruiz I, et al. 3D Dosimetric verification of volumetric-modulated arc therapy by portal

- dosimetry. *Radiother Oncol.* 2010;94(2). doi:10.1016/j.radonc.2009.12.020
177. Torres-Xirau I, Olaciregui-Ruiz I, van der Heide UA, Mans A. 2D EPID dosimetry for an MR -linac: proof of concept . *Med Phys.* Published online 2019. doi:10.1002/mp.13664
 178. Meyer P, Noblet V, Mazzara C, Lallement A. Survey on deep learning for radiotherapy. *Comput Biol Med.* 2018;98(May):126-146. doi:10.1016/j.compbio.2018.05.018
 179. Ghesu FC, Georgescu B, Zheng Y, et al. Multi-Scale Deep Reinforcement Learning for Real-Time 3D-Landmark Detection in CT Scans. *IEEE Trans Pattern Anal Mach Intell.* Published online 2019. doi:10.1109/TPAMI.2017.2782687
 180. Xu X, Zhou F, Liu B. Automatic bladder segmentation from CT images using deep CNN and 3D fully connected CRF-RNN. *Int J Comput Assist Radiol Surg.* Published online 2018. doi:10.1007/s11548-018-1733-7
 181. Miao S, Wang JZ, Liao R. Convolutional Neural Networks for Robust and Real-Time 2-D/3-D Registration. In: *Deep Learning for Medical Image Analysis.* ; 2017. doi:10.1016/B978-0-12-810408-8.00016-X
 182. Wang G, Ye JC, Mueller K, Fessler JA. Image Reconstruction is a New Frontier of Machine Learning. *IEEE Trans Med Imaging.* Published online 2018. doi:10.1109/TMI.2018.2833635
 183. Ronneberger O, Fischer P, Brox T. U-Net: Convolutional Networks for Biomedical Image Segmentation. :1-8.
 184. Nguyen D, Long T, Jia X, et al. A feasibility study for predicting optimal radiation therapy dose distributions of prostate cancer patients from patient anatomy using deep learning. *Sci Rep.* 2019;9(1):1-10. doi:10.1038/s41598-018-37741-x
 185. Olaciregui-Ruiz I, Vivas-Maiques B, Kaas J, et al. Transit and non-transit 3D <sc>EPID</sc> dosimetry versus detector arrays for patient specific <sc>QA</sc>. *J Appl Clin Med Phys.* Published online 2019:acm2.12610. doi:10.1002/acm2.12610

186. Olaciregui-Ruiz I, Rozendaal R, van Oers RFM, Mijnheer B, Mans A. Virtual patient 3D dose reconstruction using in air EPID measurements and a back-projection algorithm for IMRT and VMAT treatments. *Phys Medica*. 2017;37. doi:10.1016/j.ejmp.2017.04.016
187. Ioffe S, Szegedy C. Batch Normalization: Accelerating Deep Network Training by Reducing Internal Covariate Shift. Published online 2015.
188. Nair V, Conference GH-P of the 27th international, 2010 U. Rrte Amount. *CsTorontoEdu*. 2010;(3):6421113. doi:10.1.1.165.6419
189. Drozdal M, Vorontsov E, Chartrand G, Kadoury S, Pal C. The importance of skip connections in biomedical image segmentation. *Lect Notes Comput Sci (including Subser Lect Notes Artif Intell Lect Notes Bioinformatics)*. 2016;10008 LNCS:179-187. doi:10.1007/978-3-319-46976-8_19
190. Srivastava N, Hinton G, Krizhevsky A, Sutskever I, Salakhutdinov R. Dropout: A simple way to prevent neural networks from overfitting. *J Mach Learn Res*. Published online 2014.
191. Kingma DP, Ba J. Adam: A Method for Stochastic Optimization. Published online 2014:1-15.
192. Agarwal A, Barham P, Brevdo E, et al. TensorFlow: Large-Scale Machine Learning on Heterogeneous Distributed Systems. Published online 2015.
193. McDermott LN, Wendling M, Sonke JJ, van Herk M, Mijnheer BJ. Replacing Pretreatment Verification With In Vivo EPID Dosimetry for Prostate IMRT. *Int J Radiat Oncol Biol Phys*. 2007;67(5):1568-1577. doi:10.1016/j.ijrobp.2006.11.047
194. Winkel D, Bol GH, Kiekebosch IH, et al. Evaluation of Online Plan Adaptation Strategies for the 1.5T MR-linac Based on “First-In-Man” Treatments. *Cureus*. 2018;10(4):1-7. doi:10.7759/cureus.2431
195. Kontaxis C, Bol GH, Stemkens B, et al. Towards fast online intrafraction replanning for free-breathing stereotactic body

- radiation therapy with the MR-linac Related content Effect of intra-fraction motion on the accumulated dose for free-breathing MR-guided stereotactic body radiation therapy . *Inst Phys Eng Med Phys Med Biol.* 2017;62:7233-7248. doi:10.1088/1361-6560/aa82ae
196. Chen X, Paulson ES, Ahunbay E, Sanli A, Klawikowski S, Li XA. Measurement validation of treatment planning for a MR-Linac. *J Appl Clin Med Phys.* 2019;20(7):28-38. doi:10.1002/acm2.12651
 197. Uilkema S, Van Der Heide U, Sonke JJ, Moreau M, Van Triest B, Nijkamp J. A 1.5 T transverse magnetic field in radiotherapy of rectal cancer: Impact on the dose distribution. *Med Phys.* 2015;42(12). doi:10.1118/1.4936097
 198. Olaciregui-Ruiz I, Vivas-Maiques B, Kaas J, et al. Transit and non-transit 3D EPID dosimetry versus detector arrays for patient specific QA. *J Appl Clin Med Phys.* 2019;20(6):79-90. doi:10.1002/acm2.12610

