



Universiteit
Leiden
The Netherlands

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

Torres Xirau, I.

Citation

Torres Xirau, I. (2020, September 15). *Patient-specific in-vivo QA in MRGRT: 3D EPID dosimetry for the Unity MR-linac*. Retrieved from <https://hdl.handle.net/1887/136754>

Version: Publisher's Version

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/136754>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/136754> holds various files of this Leiden University dissertation.

Author: Torres Xirau, I.

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

Issue Date: 2020-09-15

P A T I E N T - S P E C I F I C
I N - V I V O Q A I N M R G R T :
3 D E P I D D O S I M E T R Y F O R
T H E U N I T Y M R - L I N A C

PROEFSCHIRFT

ter verkrijging van

*de graad van Doctor aan de Universiteit Leiden,
op gezag van Rector Magnificus prof.mr. C.J.J.M. Stolker,
volgens besluit van het College voor Promoties
te verdedigen op dinsdag 15 september 2020*

klokke 11.15 uur

door

*Iban Torres Xirau
geboren te Barcelona in 1987*

Dedication.

A la mama. Per cuidar-nos i estimar-nos tant.

P A T I E N T - S P E C I F I C
I N - V I V O Q A I N M R G R T :
3 D E P I D D O S I M E T R Y F O R
T H E U N I T Y M R - L I N A C

Iban Torres Xirau

*Gepersonaliseerde kwaliteitsbeoordeling door MRGRT-
behandelingen: 3D-dosimetrie met EPID voor de Unity
MR-Linac*

*Avaluació personalitzada de qualitat en tractaments
MRGRT: dosimetria 3D mitjançant EPID per a l'Unity
MR-Linac*

Promotor:

Prof. Dr. U.A. van der Heide

Co-promotor:

Dr. A. Mans (NKI-AvL)

Promotiecommissie:

Prof. Dr. C.R.N. Rasch (LUMC)

Prof. Dr. B.W. Raaymakers (UMC Utrecht)

Dr. V. Hansen (Odense Universitetshospital)

Prof. Dr A. Webb (LUMC)

Prof. Dr. R.L.M. Haas (LUMC)

Dr. N. Jornet Sala (Hospital Sant Pau Barcelona)

ISBN: 978-94-6416-129-8

Cover design: Georgina Ferrer Brutau | www.vananaprints.com

Lay-out: Publiss | www.publiss.nl

Printing: Ridderprint | www.ridderprint.nl

Copyright © I. Torres 2020.

All rights reserved. No part of this book may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, without prior written permission of the author.

The work on this thesis was performed at the Netherlands Cancer Institute in Amsterdam, and was funded by the Elekta AB (Stockholm, Sweden), grant NKI 2013 – 5937 and project 10088.

CONTENTS

Chapter 1	Introduction	11
Chapter 2	A back-projection algorithm in the presence of an extra attenuating medium: towards portal dosimetry for the MR-linac.	29
Chapter 3	Characterization of the A-Si EPID in the Unity MR-Linac for dosimetric applications	59
Chapter 4	Two dimensional EPID dosimetry for the MR-linac: proof of concept.	81
Chapter 5	3D dosimetric verification of unity MR-linac treatments by portal dosimetry.	107
Chapter 6	A Deep Learning-based correction to EPID dosimetry for attenuation and scatter in the Unity MR-Linac system	121
Chapter 7	General Discussion	141
Chapter 8	References	153
Chapter 9	Summaries	179
Chapter 10	Acknowledgments	193
Chapter 11	List of publications	199
Chapter 12	Curriculum Vitae	205

List of abbreviations:

ART	Adaptive radiotherapy
CBCT	Cone-beam computer tomography
CNN	Convolutional neural network
CT	Computed tomography
CTV	Clinical tumor volume
EPID	Electronic portal imaging device
EBRT	External-beam radiotherapy
ERE	Electron return effect
FFF	Flattening filter free
GTV	Gross tumor volume
H&N	Head and neck
IC	Ionization chamber
IMRT	Intensity modulated radiotherapy
ISQL	Inverse square law
DVH	Dose volume histogram
DL	Deep learning
DEEPID	Deep electronic portal imaging device
MLC	Multi-leaf collimator
MRI	Magnetic resonance imaging

MRIgRT	Magnetic resonance Imaging guided Radiotherapy
MU	Monitor unit
MV	Mega voltage
OAR	Organ at risk
PET	Positron emission tomography
PTV	Planning target volume
QA	Quality assessment
QC	Quality control
ReLU	Rectified linear unit
ROI	Region of interest
RT	Radiotherapy
TPS	Treatment planning system
VMAT	Volumetric arc therapy