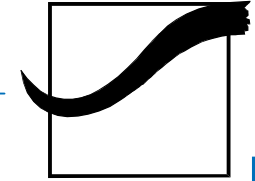


# IMRT in Leitlinien und Normen

Marius Treutwein  
Klinik und Poliklinik für Strahlentherapie  
Klinikum der Universität Regensburg

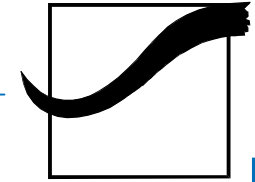




## Übersicht

- Leitlinien der ESTRO mit Bezug auf IMRT
- Weitere Leitlinien und Publikationen zur IMRT
- Leitlinien und Normen zu Bestrahlungsplanungssystemen



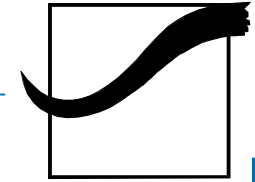


## ESTRO Guidelines I

- **Guidelines for education and training of medical physicists in radiotherapy (ESTRO)**
  - *Treatment planning (IMRT)*
    - To investigate locally available IMRT protocols and dose constraints
  - *Radiotherapy techniques:*
    - IMRT methods: static and dynamic
  - *IMRT verification*

<http://www.estroweb.org/ESTRO/upload/GUIDELINES/CC-MPhys.pdf>





## ESTRO Guidelines II

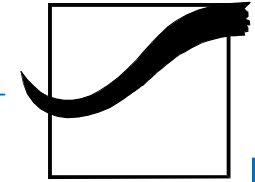
- **European Core Curriculum for RTs** (gehobene medizinisch-technische Dienste)

*Kürzliche Entwicklungen in der Computertechnologie und im Design der Linearbeschleuniger, kombiniert mit Verfeinerungen bei der Abbildung von Tumoren, machten die Entwicklung und weit verbreitete klinische Durchführung von dreidimensionaler gleichförmiger Strahlentherapie (3-DCRT) möglich. Die letzte Entwicklung in dieser Richtung war der klinische Gebrauch von Intensity-Modulated Radiation Therapy (IMRT). Sowohl die 3-DCRT als auch die IMRT Technologie haben zu einer Reduzierung der Lang- und Kurzzeiterkrankungen geführt und das Behandlungsverhältnis für viele Krebsarten verbessert. In diesem Zusammenhang hat auch die Intra-Operative Radiotherapy (IORT) Potential und wird in vielen Abteilungen eingeführt. Stereotaxie ähnelt den 3-DCRT und IMRT Technologien und umfasst zusätzlich Stereotaktische Neurochirurgische Techniken, die Linearbeschleunigertechnik und die computerisierte Behandlungsplanung. Es ist nun erwiesen, dass durch die Anwendung von höheren Strahlungsdosen, ermöglicht durch die Verwendung von 3-D und IMRT-Technologien, die Krebs-Rückfall-Rate gesunken ist.*

Deutsch: <http://www.estroweb.org/ESTRO/upload/GUIDELINES/DEccFeb2003FINAL.pdf>

Englisch: <http://www.estroweb.org/ESTRO/upload/GUIDELINES/CC-RTT.pdf>



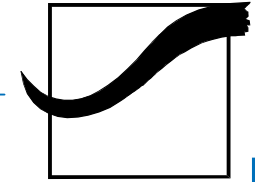


## ESTRO Guidelines III

- **Recommended Curriculum for the Specialist Training of Medical Practitioners in Radiotherapy (Radiation Oncology) within Europe**
  - **Radiation physics applied in radiation therapy (RT)**
    - Principles, technical aspects and applications of conformal RT and IMRT (1)

<http://www.estroweb.org/ESTRO/upload/GUIDELINES/CC-CLIN.pdf>





## ESTRO (Physics) Booklets

- ESTRO-Booklet: Quality Assurance of Treatment Planning Systems – Practical Examples for Non-IMRT Photon Beams (2004)  
<http://www.estroweb.org/ESTRO/upload/publications/KaftEstro7web.pdf>

QUALITY ASSURANCE OF TREATMENT PLANNING SYSTEMS  
PRACTICAL EXAMPLES FOR NON-IMRT PHOTON BEAMS

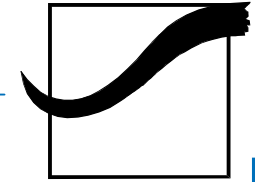
Ben Mijnheer  
Agnieszka Olszewska  
Claudio Fiorino  
Guenther Hartmann  
Tommy Knöös  
Jean-Claude Rosenwald  
Hans Welleweerd

2004 – First edition  
ISBN 90-804532-7  
© 2004 by ESTRO

All rights reserved  
No part of this publication may be reproduced,  
stored in a retrieval system, or transmitted in any form or by any means,  
electronic, mechanical, photocopying, recording or otherwise  
without the prior permission of the copyright owners.

ESTRO  
Mounierlaan 83/12 – 1200 Brussels (Belgium)





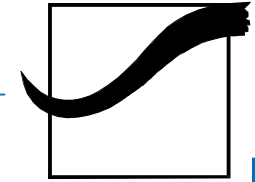
## ESTRO Projekt ESQUIRE

- Task 5: QUASIMODO **Quality Assurance** in **Intensity Modulated Radiation Oncology**
- Ziele: (ESTRO Physics Booklets)
  - *Leitlinie für Acceptance tests von Planungssystemen für Nutzer und Hersteller*
  - *Leitlinie für IMRT Verifikation*

<http://www.estro.be/>

→ *QA in ESTRO Projects*





## Leitlinie zur IMRT der DGMP und DEGRO

- Link auf der Homepage des Arbeitskreises
- Oder  
[http://www.dgmp.de/Page\\_Papiere/Bericht19.pdf](http://www.dgmp.de/Page_Papiere/Bericht19.pdf)
- [http://www.degro.org/IMRT\\_Leitlinie.pdf](http://www.degro.org/IMRT_Leitlinie.pdf)

Leitlinie zur Strahlentherapie  
mit fluenzmodulierten Feldern (IMRT)

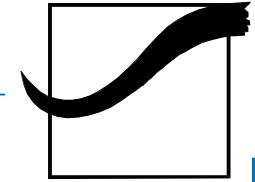
Ausgearbeitet von einem DGMP – DEGRO Arbeitsausschuss

Mitglieder:

F. Nüsslin  
(Federführender)

J. Bohsung  
T. Frenzel  
K.-H. Grosser  
F. Paulsen  
H. Sack

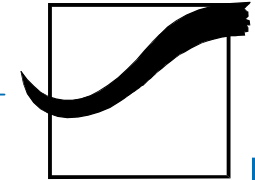




## SGSMP: Arbeitsgruppe „Quality Control in IMRT“

- Nächstes Treffen: Datum?, Bern (Uni)
- Vorsitz: Raphaël Moeckli  
E-Mail: [Raphael.Moeckli@inst.hospvd.ch](mailto:Raphael.Moeckli@inst.hospvd.ch)





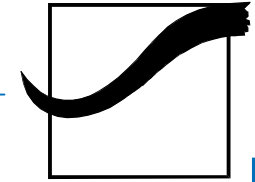
## Publikationen I

- „IMRT Collaborative Working Group“ der ASTRO; Int. J. Radiation Oncology Biol. Phys. Vol. 51, No 4 pp. 880-914, 2001)

### TABLE OF CONTENTS

ABSTRACT	<i>IMRT treatment plan test cases QA checks of monitor unit calculations IMRT treatment verification</i>
INTRODUCTION	<i>Recommendations: Acceptance testing, commissioning, and QA of IMRT systems and treatment verification</i>
IMRT HISTORICAL REVIEW	
<i>3D treatment planning systems Precursors to IMRT delivery systems</i>	
IMRT DELIVERY TECHNIQUES	
<i>Scanned photon and electron beam IMRT Tomotherapy IMRT Conventional multileaf collimator IMRT Physical modulator (compensating filter) IMRT Robotic linear accelerator IMRT</i>	
COMPUTER OPTIMIZATION	
<i>Objective functions Computer optimization (search) process Leaf sequence generation</i>	
DOSE DISTRIBUTION AND MONITOR UNIT CALCULATIONS FOR IMRT	
<i>Calculation algorithm types Important issues for IMRT dose calculations Monitor unit calculations for IMRT Recommendations: IMRT dose calculations</i>	
IMRT ACCEPTANCE TESTING, COMMISSIONING, AND QA	
<i>Acceptance testing of the IMRT treatment planning system Verification of IMRT dose distributions</i>	
	<b>FACILITY PLANNING AND RADIATION SAFETY</b>
	<i>Workload estimates Dose rate and calibration changes Shielding design Patient whole-body dose Recommendations: Facility planning and radiation safety</i>
	<b>TARGET VOLUME AND DOSE SPECIFICATION AND REPORTING</b>
	<i>Target volume specification Dose specification Recommendations: Target volume and dose specification</i>
	<b>CLINICAL EXPERIENCE</b>
	<b>SUMMARY AND CONCLUSIONS</b>
	<b>ACKNOWLEDGMENTS</b>
	<b>APPENDIX A: IMRT NOMENCLATURE</b>
	<b>REFERENCES</b>

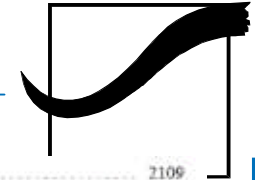




## Publikationen II

- 2002: Protocol Requirements NCI  
[http://www.rtog.org/pdf\\_document/IMRT-RTOG.pdf](http://www.rtog.org/pdf_document/IMRT-RTOG.pdf)  
Offener Brief, verweist auf
  - „*IMRT Collaborative Working Group*“ (vorangehende Seite)
  - *ICRU 50 und ICRU 62; Konzept des Planning Organ at Risk Volumes (PRV)*





## Publikationen III

Ezzel, G.A., Galvin, J. M, Low, D.A., Palta, J., Rosen, I., Sharpe, M., Xia, P., Xiao, Y., Xing, L., Yu, C., Guidance document on delivery, treatment planning, and clinical implementation of IMRT: Report of the IMRT subcommittee of the AAPM radiation therapy committee, *Med.Phys.* 30 (2003) 2089

### TABLE OF CONTENTS

I. INTRODUCTION.....	2090	II. DELIVERY SYSTEMS FOR IMRT.....	2091
A. Relation of intensity-modulated radiation therapy (IMRT), three-dimensional conformal radiation therapy (3DCRT), and traditional practice.....	2090	A. General issues of IMRT delivered with MLC.....	2091
B. Objectives for this document.....	2090	1. MLC leaf positional accuracy.....	2091
C. Organization of this document.....	2091	2. Linac performance for small MU delivery.....	2093
		3. MLC control issues.....	2093
		4. MLC physical characteristics.....	2093
		B. Additional issues with dynamic IMRT with MLC.....	2094

1. MLC leaf positional and leaf speed accuracy.....	2094	8. Position verification.....	2109
2. Other dynamic MLC issues.....	2095	9. IMRT treatment delivery.....	2109
C. IMRT with physical attenuators.....	2095	E. QA of equipment and individual patient treatments.....	2110
D. IMRT with rotating fan beams (tomotherapy).....	2095	F. Staff training and patient education.....	2110
1. Peacock positional accuracy.....	2095	1. Radiation oncologists.....	2110
2. Peacock dosimetric measurements.....	2096	2. Radiation oncology physicists.....	2110
3. Helical tomotherapy.....	2096	3. Dosimetrists.....	2111
E. IMRT with rotating cone beams (intensity-modulated arc therapy).....	2096	4. Radiation therapists.....	2111
F. Leaf sequencing for segmental and dynamic IMRT with MLCs.....	2096	5. Service engineers.....	2111
1. Sliding window algorithms.....	2096	6. Patient education.....	2111
2. Areal or reducing algorithms.....	2097	G. Patient scheduling, billing, and charting.....	2112
III. TREATMENT PLANNING FOR IMRT.....	2098	H. Overall integration.....	2112
A. Differences between IMRT and conventional treatment planning: dose calculations and beam modeling.....	2098	V. SUMMARY.....	2112
1. Modeling head scatter, penumbra, and transmission.....	2098		
2. Leaf sequencing and deliverability.....	2098		
3. Heterogeneity corrections.....	2098		
B. Differences between IMRT and conventional treatment planning: Planning algorithms.....	2099		
C. Differences between IMRT and conventional treatment planning: Specific planning issues.....	2100		
1. Dose uniformity vs dose shaping.....	2100		
2. Target and structure delineation.....	2100		
3. Dose grid.....	2101		
4. Bulkup region.....	2101		
5. Flash and mobile targets.....	2101		
6. Margins.....	2101		
7. Radiobiologic issues.....	2102		
8. Plan evaluation.....	2102		
D. Learning how to use the inverse planning system.....	2103		
E. Commissioning an IMRT planning system for dosimetric accuracy.....	2103		
F. QA of individual treatment plans.....	2105		
1. Independent calculation methods.....	2105		
2. Verification measurements.....	2105		
3. Other plan checks.....	2106		
IV. CLINICAL IMPLEMENTATION OF IMRT.....	2106		
A. Overview.....	2106		
B. Equipment and space requirements.....	2107		
1. Shielding.....	2107		
2. Space planning.....	2107		
3. Equipment.....	2107		
C. Time and personnel requirements.....	2107		
D. Changes in treatment planning and treatment delivery process.....	2107		
1. General considerations.....	2107		
2. Immobilization.....	2107		
3. Image acquisition.....	2107		
4. Structure segmentation.....	2108		
5. IMRT treatment planning.....	2108		
6. File transfer and management.....	2108		
7. Plan validation.....	2109		

### I. INTRODUCTION

#### A. Relation of intensity-modulated radiation therapy (IMRT), three-dimensional conformal radiation therapy (3DCRT), and traditional practice

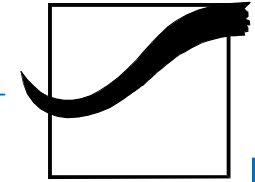
IMRT is an extension of 3DCRT that uses nonuniform radiation beam intensities that have been determined by various computer-based optimization techniques. Three-dimensional conformal therapy is a change from traditional practice in that it uses targets and normal structures identified on multiple transverse images, field design based on beam's eye view projections, volumetric dose calculations, and volumetric plan evaluation tools such as dose-volume histograms (DVHs). IMRT uses all the tools of 3DCRT and adds other novel features. IMRT seeks to further shape dose distributions by modulating the intensity of each field. Thus, new capabilities of linear accelerators (linacs) and collimators must be installed, commissioned, and maintained. Also, computing the needed intensity patterns and machine instructions to create them complicates the treatment planning process significantly. The computer algorithms associated with IMRT planning must be commissioned for dosimetric accuracy. Users must learn how to use inverse planning systems to produce and evaluate high quality plans. These are new tasks that physicists and other radiation oncology staff must accomplish. Many physicists and their colleagues are now struggling with the question of "what do I need to know and do to implement IMRT safely and effectively?"

#### B. Objectives for this document

The objectives for this document are

- to describe in general terms how IMRT differs from 3DCRT with respect to treatment delivery, treatment planning, and clinical implementation and give references so readers can get more details if desired;
- to describe how these differences impact commissioning of the treatment planning and delivery systems, and provide guidance on the commissioning process;
- to describe the impact on ongoing quality assurance (QA) and provide guidance on QA practice, and

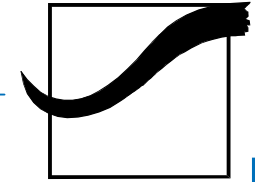




## Normen zu Bestrahlungsplanungssystemen

- DIN 6873-5 - **Norm** , 1993-08  
Bestrahlungsplanungssysteme; Konstanzprüfungen von Qualitätsmerkmalen
- DIN EN 62083 - **Norm** , 2002-05 Medizinische elektrische Geräte - Festlegungen für die Sicherheit von Bestrahlungsplanungssystemen (IEC 62083:2000); Deutsche Fassung EN 62083:2001
- OENORM S 5295 - **Norm** , 2004-11-01  
Bestrahlungsplanungssysteme - Konstanzprüfungen von Qualitätsmerkmalen



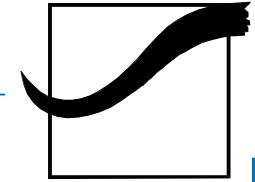


## Qualitätssicherung von Bestrahlungsplanungssystemen

- Normen der vorhergehenden Seite
- ESTRO-Booklet: Quality Assurance of Treatment Planning Systems – Practical Examples for Non-IMRT Photon Beams (2004)  
<http://www.estroweb.org/ESTRO/upload/publications/KaftEstro7web.pdf>
- Leitlinie der SGSMP 1997 (Webversion 1999)  
„Quality Control of Treatment Planning Systems“  
<http://www.sgsmp.ch/r07tps-e.htm>  
Arbeitsgruppe neu konstituiert; Vorsitz: Pierre-Alain Tercier, E-mail: pierre\_alain.tercier@freesurf.ch
- IAEA: Commissioning and Quality Assurance of Computerized Planning Systems for Radiation Treatment of Cancer (2004)  
[http://www-pub.iaea.org/MTCD/publications/PDF/TRS430\\_web.pdf](http://www-pub.iaea.org/MTCD/publications/PDF/TRS430_web.pdf)
- AAPM-Report, TG53, Quality assurance for clinical radiotherapy treatment planning, Med.Phys. 25(10) Oct 1998  
[http://www.aapm.org/pubs/reports/rpt\\_62.pdf](http://www.aapm.org/pubs/reports/rpt_62.pdf)







Deutsche Gesellschaft für  
Medizinische Physik e.V.

## 37. Jahrestagung für Medizinische Physik



20. - 23. September 2006  
Regensburg

