

**Eighth International Conference on the
USE OF COMPUTERS
IN RADIATION THERAPY**

**Proceedings
1984**

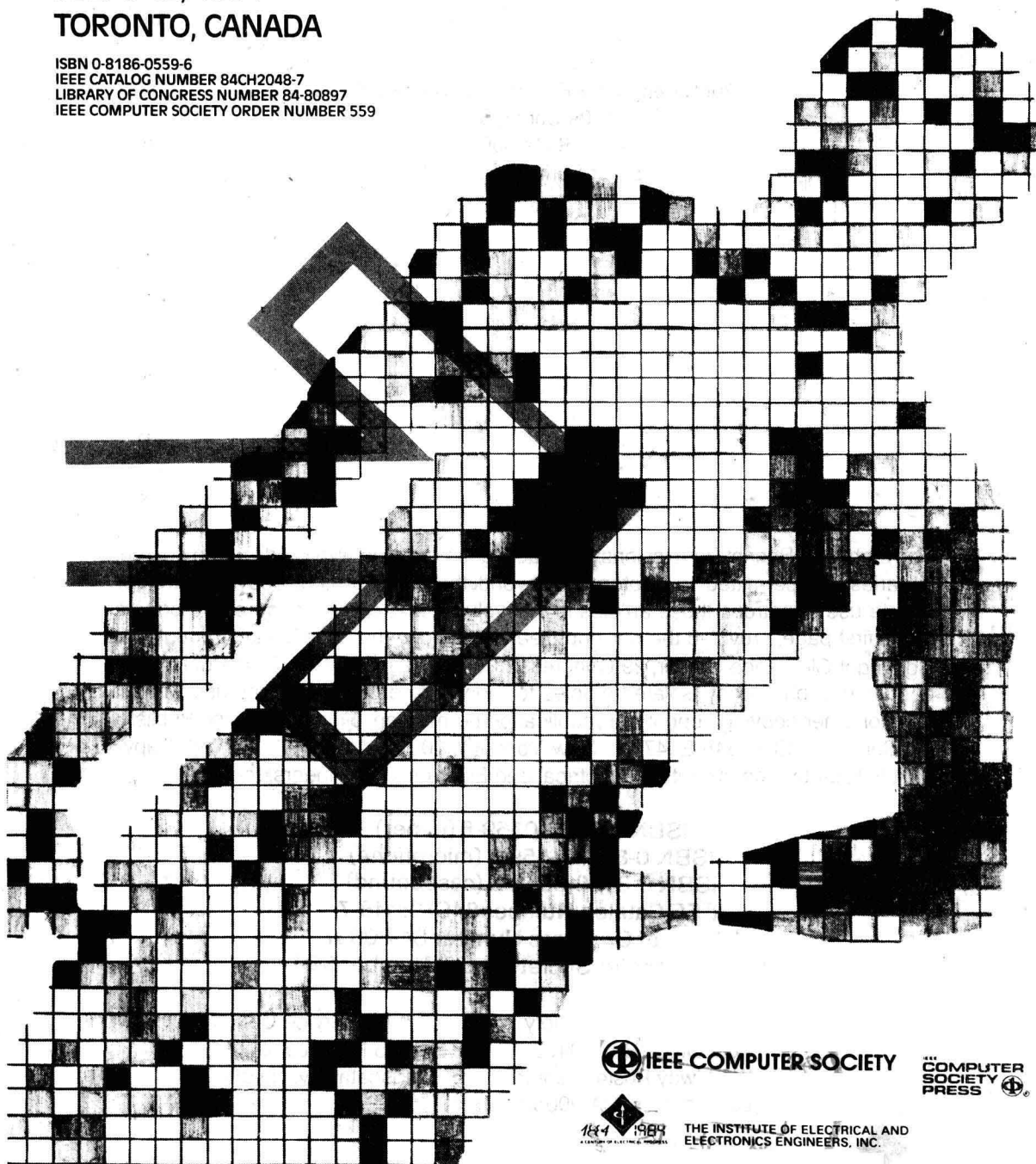
PROCEEDINGS

Eighth International Conference on the USE of COMPUTERS IN RADIATION THERAPY

JULY 9-12, 1984

TORONTO, CANADA

ISBN 0-8186-0559-6
IEEE CATALOG NUMBER 84CH2048-7
LIBRARY OF CONGRESS NUMBER 84-80897
IEEE COMPUTER SOCIETY ORDER NUMBER 559



IEEE COMPUTER SOCIETY

COMPUTER
SOCIETY
PRESS



THE INSTITUTE OF ELECTRICAL AND
ELECTRONICS ENGINEERS, INC.

PRINTED IN THE UNITED STATES OF AMERICA

The papers appearing in this book comprise the proceedings of the meeting mentioned on the cover and title page. They reflect the authors' opinions and are published as presented and without change, in the interests of timely dissemination. Their inclusion in this publication does not necessarily constitute endorsement by the editors, IEEE Computer Society Press, or the Institute of Electrical and Electronics Engineers, Inc.

Published by IEEE Computer Society Press
1109 Spring Street
Suite 300
Silver Spring, MD 20910

Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limits of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through the Copyright Clearance Center, 29 Congress Street, Salem, MA 01970. Instructors are permitted to photocopy isolated articles for noncommercial classroom use without fee. For other copying, reprint or republication permission, write to Director, Publishing Services, IEEE, 345 E. 47 St., New York, NY 10017. All rights reserved. Copyright © 1984 by The Institute of Electrical and Electronics Engineers, Inc.

ISBN 0-8186-0559-6 (paper)
ISBN 0-8186-4559-8 (microfiche)
ISBN 0-8186-8559-X (casebound)
IEEE Catalog Number 84CH2048-7
Library of Congress Number 84-80897
IEEE Computer Society Order Number 559

Order from: IEEE Computer Society
Post Office Box 80452
Worldway Postal Center
Los Angeles, CA 90080

IEEE Service Center
445 Hoes Lane
Piscataway, NJ 08854



The Institute of Electrical and Electronics Engineers, Inc.

Officers of the Conference

Organizing Committee

J. Van Dyk
J.R. Cunningham (chairman)
Dave Hall
Harold Perry
Don Ragan
E.S. Sternick

Local Arrangements

J. Van Dyk (chairman)
J.R. Cunningham
May Marinacci

Program Committee

J. Van Dyk
J.R. Cunningham
R. Curley
J. van de Geijn
Harold Perry
D. Ragan (chairman)
E.S. Sternick
N. Suntharalingam

Exhibits

Dave Hall (chairman)

Regional Representatives

C.E. de Almeida (Brazil)
R. Bentley (UK)
J. Cederlund (Sweden)
J.R. Cunningham (Canada)
J. Drew (Australia)
A. Dutreix (France)
P.H. van der Giessen (The Netherlands)
F. Nuesslin (FRG)
Y. Onai (Japan)
D. Ragan (USA)
U. Rosenow (FRG)
D. Shackleton (R. South Africa)
E. Takenaka (Japan)
T'ang Hui (P.R. China)
M. Thatcher (Israel)
J. Telich (Mexico)

Acknowledgments

The organizing committee would like to acknowledge the generous assistance of many members of the staff and students of the Ontario Cancer Institute including Ms. E. Govoni and the OCI Accounting Department for handling the conference accounts. Ms. May Marinacci deserves special mention for handling the mammoth task of all the xeroxing, mailing and registration.

We would also like to acknowledge the financial support of the Princess Margaret Hospital Trust Fund for sponsoring one of the conference social evenings, and Atomic Energy of Canada Ltd for designing and printing the 8th ICCR stationery.

PREFACE

The 8th International Conference on uses of Computers in Radiotherapy is the 8th in a series of small ad hoc conferences designed to promote uses of computers in radiotherapy in the hopes of improving the practice of that subject. Participation has, by early design and later by tradition, been by invitation. The intent was and is to gather physicists, clinicians and computer technologists that are in the forefront of this subject together. The meetings have always been characterized by a spirit of friendliness and good conversation. The present meeting, in Toronto, Canada is in line with this tradition.

Publications have also resulted from all of the previous meetings and it may be useful to list the meetings and their publications.

1. Cambridge, England, 1966
"The Use of Computers in Therapeutic Radiology", Special Report No. 1. British Institute of Radiology, London, 1967.
2. Chicago, U.S.A., 1968
M. Cohen, "Computers in Radiotherapy", (Special Report No. 4). Brit. J. Rad. 43, 658-663, 1970.
3. Glasgow, Scotland, 1970
"Computers in Radiotherapy", Special Report No. 5. British Institute of Radiology, London, 1971.
4. Uppsala, Sweden, 1972
"Computers in Radiation Therapy", Radiofysikavdelningen, Akademiska Sjukhuset. S-75014. Uppsala, Sweden, 1972.
5. Hanover, N.H., U.S.A., 1975
"Computer Applications in Radiation Oncology". E.S. Sternick, Ed. University Press of New England, 1976.
6. Goettingen, Federal Republic of Germany, 1977
"Computers in Radiotherapy", U. Rosenow, Ed. Strahlenabteilung Universitaets Frauenklinik, D-3400, Goettingen, FRG, 1978.
7. Kawasaki and Tokyo, Japan, 1980
"Computers in Radiation Therapy", Umegaki, Ed. Japan Radiological Soc. Tokyo, Japan, 1981.

These meetings, spanning almost twenty years, have gone from the time of looking for useful applications for the computer to the present, when it is thought by many that for proper radiotherapy a computer is essential.

It is probably safe to say that during the early years of the conferences, the activity that contributed most to the practice of radiotherapy was the development of accurate treatment planning systems. This has undoubtedly led to an improvement in the accuracy of treatments but it is not easy to show that it has also led to an improvement in results although there are many who firmly believe that this is so.

In the early conferences, considerable discussion took place concerning the merits of small computers versus large computers. Now, computers more powerful than many of the "large" systems of that time are household items. Hardware is still important but now the attention is to particular problems and the "Micros" can do many specialized tasks with efficiency and precision. On the other hand, large computers have become so powerful that it is now becoming practical to use Monte Carlo techniques, if not for routine dosage calculations, at least for analysis of dosimetric problems.

Development of dose calculation algorithms is still held to be important as can be judged from the number of papers presented to this conference. Fully one third of them are on that topic.

Hounsfield published his first paper on CT just after the 4th (Uppsala) ICCR and NMR appeared on the scene for imaging about the time of the 7th meeting. Not surprisingly attention has shifted to imaging and display and to find ways of using the vast and detailed amount of anatomical information that is becoming available for both diagnosis and treatment.

Optimization of radiation treatments, discussed even at the time of the first meeting, is still of interest and is a problem that is almost as far from solution as then. Perhaps until biological response can be well incorporated into treatment planning "optimization" can not be fully realized.

The capture and analysis of patient records and related data is still of interest and a number of papers devoted to that subject appear in this volume.

This publication represents a collection of papers on these subjects and others. They appear as produced by the authors. They are arranged in the order in which they appear in the program except that there are three simultaneous sessions with papers 1 through 48 being given concurrent with 49 through 93 and 94 through 137.

It is hoped, and indeed expected, that this publication, being available at the time of the meeting, will be especially useful during it but will also be referred to for years to come.

J.R. Cunningham
D. Ragan
J. Van Dyk

Table of Contents

Officers of the Conference	iii
Acknowledgments	iv
Preface	v
Invited Papers	1
Treatment Planning — Past Shortfalls and Future Needs	2
<i>W.E. Powers</i>	
Applications of Computer Technology in Medicine	3
<i>J.R. Cox, Jr.</i>	
Toward a Biological Basis for Treatment Planning	4
<i>J. Dutreix</i>	
Contributed Papers	13
Dose Calculations in Photon Beams	
Photon Beam Modeling Using Fourier Transform Techniques	14
<i>A.L. Boyer and E.C. Mok</i>	
Application of Transform Algorithms for Calculation of Absorbed Dose in Photon Beams	17
<i>A. Ahnesjo</i>	
An Algorithm for Using CT-Data in Radiation Therapy Dose Planning	21
<i>J. Viitanen, V. Taskinen, and M. Ojanen</i>	
The Delta-Volume Method for Three-Dimensional Photon Dose Calculations	26
<i>J.W. Wong, E.D. Slessinger, F.U. Rosenberger, K. Krippner, and J.A. Purdy</i>	
Lung Dose Corrections for 6MV and 15MV X-Rays: Anomalies	31
<i>J.J. Battista, T.R. Mackie, E. El-Khatib, and J.W. Scrimger</i>	
Computing Radiation Dose for High Energy X-Rays Using a Convolution Method	36
<i>T.R. Mackie and J.W. Scrimger</i>	
Investigation of the Accuracy of Calculations for Irregularly Shaped Photon Beams	41
<i>H.J. van Kleffens, F.W. Jacobs, P.M. van der Linden, J. Venselaar, and R. Thieme</i>	
Determination of the Accuracy of the Tissue Inhomogeneity Correction in Some Computer Planning Systems for Megavoltage Photon Beams	45
<i>H.J. van Kleffens and B.J. Mijnheer</i>	
Irregular Field Modeling of an 18 MV X-Ray Beam Using the Program CBEAM	50
<i>M.T. Gillin, R.W. Kline, A. Niroomand-Rad, and D.F. Grimm</i>	
Radiation Treatment Prediction of Dose at the Bone-Tissue Transition Zone	57
<i>L.D. Simpson, H.M. Kooy, J.A. McFaul, and R. Graves</i>	
Numerical Approximation of the Clarkson Scatter Integral	58
<i>B.A. Lulu</i>	
The Affect of Off-Axis Energy Change in a Linear Accelerator on the TAR/SAR Algorithm	63
<i>J.F. Drew</i>	
Dose Calculation for Non Perpendicular Incidence of the Radiation Beam Using Differential Scatter-Air Ratios	64
<i>J. Richter</i>	

Accuracy of Dose Calculation for Irregular Fields	68
<i>J. Richier</i>	
Method for Making Absorbed Dose Calculations Using Two Electron Spread Functions for Primary and Using Two Differential Equations for Scatter	73
<i>A. Iwasaki</i>	
Implementation of the Delta-Volume Dose Calculation Algorithm	78
<i>F. Rosenberger, K. Krippner, D. Stein, Jr. and J. Wong</i>	
Performance Evaluation of an Algorithm for Optimization with Compensating Filters	83
<i>N. Ulso and J.J. Christensen</i>	
A Photon Beam Subtraction Method for Inhomogeneity Corrections in Computerized Treatment Planning	88
<i>K. Kappas and J.C. Rosenwald</i>	
The Projective Beam Model: An Update on Model and Characteristic Data	94
<i>J. van de Geijn, B.A. Fraass, R.W. Miller, and R.H. Creecy</i>	
A Fast Algorithm to Calculate Three Dimensional Dose Distributions for Radiosurgery	99
<i>G.H. Hartmann, W. Schlegel, V. Sturm, and W.J. Lorenz</i>	
A Technique for the Rapid Generation of Isodose Distributions for Blocked Fields	103
<i>V. Smith and A. Stuart</i>	
Present Status of Proton Radiotherapy Facilities in Japan	108
<i>T. Inada, A. Maruhashi, K. Kawachi, and T. Kanai</i>	
Real Time CT-Linked Optimization of Treatment Planning	113
<i>K. Ikamura</i>	
Graphical Simulation and Design of Beam Portal Blocking	114
<i>D.L. McShan and A.S. Glickman</i>	
Dose Calculations in Electron Beams	
Implementation of an Electron Pencil Beam Algorithm in the TP-11 Planning System	119
<i>P. van der Linden, W. Brouwer, and H. van Gasteren</i>	
A Macroscopic Monte Carlo Method for Electron Beam Dose Calculations: A Proposal	123
<i>T.R. Mackie and J.J. Battista</i>	
A Numerical Solution of the Half Slab Problem in Pencil Beam Theory	128
<i>P.R.M. Storch and H. Huizenga</i>	
A New Shape-Fitting Method for Computerised Electron Beam Radiotherapy Planning	130
<i>D. Shackleton</i>	
Three Dimensional Electron Beam Dose Calculations	132
<i>P. Bloch, M.D. Altschuler, R.E. Wallace, and J. Baren</i>	
Characterization of Elementary Electron Beams	137
<i>F. Nuesslin</i>	
Monte Carlo Calculations of Electron Beams in Standard Dose Planning Geometries	140
<i>D.W.O. Rogers, A.F. Bielajew, and A.E. Nahum</i>	
A Simple Numerical Method for Surface Dose Calculation in Rotational Total Skin Electron Irradiation	145
<i>C. Pla, R. Heese, M. Pla, and E.B. Podgorsak</i>	

Treatment Planning with High Energy Electron Beams	151
<i>A. Dutreix, F. Briot, J.Y. Amathieu, C. Beurtheret, and C.H. Amar</i>	
An Electron Beam Dose Planning Method for Arbitrary Field Shapes	152
<i>I.A.D. Bruinvis, R. van der Laarse, W.A.F. Mathol, and M.F. Nooman</i>	
Limitations of Pencil Beam Algorithms in Electron Beam Dose Planning	157
<i>A. Brahme and B. Nilsson</i>	
Pencilbeam Parameters of Clinical Electron Beams	161
<i>J.J.M. van Gasteren</i>	
Planning and Imaging	
Primary Energy Deposition by a Pencil of Electrons	167
<i>C. Park</i>	
The Use of NMR Images for Radiation Therapy Treatment Planning	168
<i>M.R. Sontag, J.M. Galvin, L. Axel, and P. Bloch</i>	
The Early Applications and Potential Usefulness of NMR in Radiation Therapy Treatment Planning	173
<i>C.W. Coffey, H.C. Hines, P.C. Wang, and S.L. Smith</i>	
Is Magnetic Resonance Imaging Useful for Radiation Therapy Planning?	181
<i>R.M. Henkelman, P.Y. Poon, and M.J. Bronskill</i>	
Digital Imaging for Planning of Radiotherapy - Practical Considerations	186
<i>I.-L. Lamm and H. Dahlin</i>	
Practical Considerations in Multi-Dimensional Treatment Planning	190
<i>M. Goitein</i>	
Three-Dimensional Dose Planning Using Tomographic Data	191
<i>W. Schlegel, H. Scharfenberg, J. Doll, G. Hartmann, V. Sturm, and W.J. Lorenz</i>	
Software Design for a 3-D Treatment Planning System	197
<i>P.K. Kijewski</i>	
3-D Ray Depth Calculation for Radiotherapy Applications	201
<i>R.L. Siddon and P.K. Kijewski</i>	
Development of a CT Based 3-D Radiation Treatment Planning System	205
<i>T. Irifune, Y. Onai, T. Tomaru, I. Uchida, Y. Umegaki, and K. Kaneta</i>	
An Interactive CT-Based Treatment Planning System for 3-D Dose Calculations	210
<i>M.R. Sontag, M.D. Altschuler, and P. Bloch</i>	
Extension of the Equivalent Tissue-Air Ratio Method to Rotational Therapy and Irregularly Shaped Beams	214
<i>M.R. Sontag</i>	
3D Display of Radiotherapy Treatment Plans	219
<i>J.P. Houlard and A. Dutreix</i>	
Optimization	
Feasibility Solutions in Radiation Therapy Treatment Planning	220
<i>M.D. Altschuler and Y. Censor</i>	
Treatment Planning by Computer Decision	225
<i>T.E. Schultheiss</i>	
A New Type of Visual Optimization Method in Treatment Planning	230
<i>K. Inamura, S. Abe, Y. Ueda, K. Shigaki, S. Fujino, and T. Matsuda</i>	
3 Dimensional Treatment Planning with a Deanza Graphic/PDP-11 Computer	235
<i>A. Chung-Bin, S.-D. Kang, and T. Wachtor</i>	
Mathematical Model for Muti-Dimensional Dose Computation	238
<i>A. Chung-Bin, T. Wachtor, and D. Fried</i>	

Lower Integral Doses and Organ Loads as a Reason for Electron Depth Therapy	243
<i>D. Fehrentz, B. Kimmig, and G.A. Zakaria</i>	
Optimization of Electron-Proton Mixed Beam Planning	248
<i>R.S. Fields and K.R. Hogstrom</i>	
Clinical Radiobiology	
Quantitative Measurement of Lung Density Changes Following Lung Irradiation	255
<i>K.Mah, J. Van Dyk, and T. Keane</i>	
An Isoeffect Program for the GE RT/Plan	260
<i>R.L. Nicholls and D.R. Wigg</i>	
Dose Volume Histograms in Treatment Planning Evaluation of Carcinoma of the Pancreas	264
<i>C.T.Y. Chen, M. Austin-Seymour, J.R. Castro, J.M. Collier, J.T. Lyman, S. Pitluck, W.M. Saunders, and S.R. Zink</i>	
Dosimetric Precision Requirements in Radiation Therapy	269
<i>A. Brahme</i>	
Appearance, Clinical Significance, and Management of Irreal Physical Quantities in Radiation Treatment Optimization	275
<i>M. Busch</i>	
Late Stage, Radioresistant, Malignant Tumour Treated by Local Hyperthermia Combined with Radiotherapy: A Preliminary Clinical Observation of 77 Cases	277
<i>H. T'ang and Z.Y. Wang</i>	
Special Problems	
The Use of a Simulator and Treatment Planning Computer as a CT Scanner for Radiotherapy Planning	281
<i>A.T. Redpath and D.H. Wright</i>	
Radiation Shielding Calculations Using a Computer	288
<i>A.L. Boyer and E.C. Mok</i>	
Computer Aided Instruction of Radiotherapy Residents	290
<i>A.L. Boyer and E.C. Mok</i>	
The Use of a Desk-Top Microprocessor for Treatment Verification and Other Radiotherapy Tasks	291
<i>B. Stedeford and A. Welsh</i>	
Quality Assurance	
Time Varying Dose Due to Respiratory Motion During Radiation Therapy of the Thorax	294
<i>K. Mah and M. Henkelman</i>	
Patient Movements and Automation in Radiotherapy	299
<i>B. Stubbs and H. Norwood</i>	
An Ongoing Quality Assurance Program for CT Interfaced Treatment Planning Computers: Initial Experience	303
<i>C.W. Coffey, H.C. Hines, D.W. Eckert, and J.L. Martin</i>	
Constancy Checks as Part of Quality Control of a Treatment Planning Computer	310
<i>F. Nuesslin</i>	
Quality Evaluation of External Beam Therapy by Utilizing CT Images	313
<i>Y. Araki, Y. Isobe, S. Ozaki, T. Hosoki, S. Mori, and H. Ikeda</i>	
The Establishment of a Beam Data and Treatment Plan Library for the Quality Assurance of Treatment Planning Systems	318
<i>U. Rosenow, F. Nuesslin, and W. Wendhausen</i>	

Italian National Program of Dosimetry Standardization in Radiotherapy: Quality Control in Dose Distributions	321
<i>R. Renzi, L. Andreucci, M. Bucciolini, and F. Milano</i>	
Quality Assurance Program for Computers in Radiotherapy: Progress Report	322
<i>D. Lepinoy, P. Aletti, G. Boisserie, H. Bouhnick, G. Estrade, M.T. Hoornaert, J.C. Houy, P. Piret, A. Piron, C. Redon, and J.C. Rosenwald</i>	
Development and Use of the SINCER Verification System	328
<i>P.H. van der Giessen</i>	
Dose in Lung Tissue Under Shielding Blocks: A Comparison of Calculations by Commercial Systems with Measurements	333
<i>M. Thatcher and S. Palti</i>	
Dose Correction for Oblique Incidence of Megavoltage Photon Beams	335
<i>C.F. Westermann and B.J. Mijnheer</i>	
Standardized Protocol of CT Image Processing for Three Dimensional Radiotherapy Planning	339
<i>M. Takizawa and J.R. Cunningham</i>	
Image Processing Techniques Applied to Fluoroscopic X-Ray Pictures Obtained from a Radiotherapy Simulator	343
<i>D.H. Wright, A.T. Redpath, J.H.G. Jarvis, and J.R. Harris</i>	
Brachytherapy	
Computerized Three Dimensional Dose Distribution of Fletcher-Suit-Delclos Colpostat Using Measured Isodose Contours	350
<i>E.D. Yorke, J.W. Gaskill, and C.C. Ling</i>	
Models for Iridium-192 Seed Implants	354
<i>I.I. Rosen and K.M. Rowinski</i>	
Interstitial Implant Contiguous Volume Evaluation Using Volumes Defined by the Seeds as Markers	359
<i>D.L. Neblett, A.M.N. Syed, A.A. Puthawala, R. Harrop, and S.E. Hogan</i>	
The Determination of Source-Position Times in Intracavitary Radiotherapy	362
<i>S. Pistorius and W.A. Groenewald</i>	
An Algorithm for Ovoid Shielding of a Cervix Applicator	365
<i>R. van der Laarse and H. Meertens</i>	
A Simple Approximation of the Point-Dose Function	370
<i>H.-K. Leetz</i>	
Planes of Computation and Display for Brachytherapy Dose Distribution	372
<i>J. Toraskar, R. Mohan, and L.L. Anderson</i>	
The Value of Dose Distribution Computations in Intracavitary Therapy	377
<i>J.M. Wilkinson</i>	
Clinical Aspects of Intracavitary High Dose-Rate Afterloading	380
<i>R. Frischkorn and U. Rosenow</i>	
Physical Aspects in the Optimization of Intracavitary High-Dose Rate Afterloading Treatments	385
<i>U. Rosenow, U. Burmester, M. Martin, and F. Frischkorn</i>	
Methods for Acquiring and Reconstructing the Geometry of the Sources Used in Interstitial and Endocavitary Radiotherapy	389
<i>M. Buccioline, L. Andreucci, F. Milano, and R. Renzi</i>	
Brachytherapy Optimization at Memorial Hospital	390
<i>L.L. Anderson, R. Mohan, B.S. Hilaris, and D. Nori</i>	

Computerized Optimization of Treatment Planning in the Brachytherapy of Brain Tumours	395
<i>B. Bauer, W. Schlegel, H. Scharfenberg, V. Sturm, and W.J. Lorenz</i>	
Analytic Optimization Method for Afterloading Techniques	399
<i>M. Busch</i>	
Clinical Requirements of Treatment Planning Systems: Brachytherapy Part I: Specifications	403
<i>G.K. Edmundson and A.A. Martinez</i>	
Clinical Requirements of Treatment Planning Systems: Brachytherapy Part II: Acceptance Testing and Verification	404
<i>G.K. Edmundson and A.A. Martinez</i>	
Quality Assurance (Record and Verify)	
A Computer-Controlled Monitoring System of Irradiation Conditions in Radiation Therapy Facilities	405
<i>T. Takahashi and H. Arima</i>	
Clinical Experience with a Computerized Record and Verify System	406
<i>K.C. Podmaniczky, R. Mohan, J. Kutcher, and C. Kestler</i>	
Verification of the Setup Parameters in Radiotherapy Simulator	407
<i>T. Lahtinen, P. Vainio, M.R. Lahtinen, and H. Puurunen</i>	
Initial Experience with the Siemen's Record and Verify System	409
<i>M.T. Gillin, R.W. Kline, and S. Derus</i>	
Experiences with a System for Verification and Recording in Radiotherapy	412
<i>T.O. Green, V. Jetne, and T. Strickert</i>	
Human Mistakes in Radiotherapy Calculations: Implications for Computerized Quality Assurance Systems	416
<i>D. Morrey, C.W. Smith, and W.H. Sutherland</i>	
Micros	
The Role of Micro-Computers in Radiation Therapy Departments	422
<i>P. Morris and P. Dickof</i>	
Applications of Microprocessors and Personal Computers	428
<i>E.S. Martell</i>	
An Interface to Program a Therados RFA-3 Through a VAX 11/780 Computer	434
<i>P.J. Biggs, D.B. Mento, M.D. Russell</i>	
A Microcomputer-Based Radiotherapy Beam Flatness Monitor	436
<i>J.W. Andrew and J.E. Aldrich</i>	
Microcomputer Upgrade for Radiotherapy Simulators	439
<i>J.E. Aldrich and J.W. Andrew</i>	
Compensator Filters Made with Compact Moire Camera and Computer	441
<i>E.C. Mok and A.L. Boyer</i>	
Solution of Linear Equation Systems by Micro Assembler Program	444
<i>M. Busch</i>	
Archiving Radiotherapy Information on a Video Disc	445
<i>D.P. Ragan, W.E. Powers, and P. English</i>	
Microcomputer Controlled 3-D Body Contour Digitizer	449
<i>J.B. Grant, P.M.K. Leung, and W.B. Taylor</i>	
Automated Design and Cutting of Compensating Filters for Precision Radiotherapy Using Multi-CT Image Information	452
<i>M. Takizawa, K. Maruyama, J.R. Cunningham, P.M.K. Leung, and J. Van Dyk</i>	

An Application of Equivalent TAR Method to Fast Reconstructor of Three Dimensional Dose Distribution	456
<i>K. Inamura, S. Abe, Y. Ueda, K. Shigaki, and S. Fujino</i>	
The Use of a Display/Array Processor Combination in Radiation Therapy Treatment Planning	461
<i>B. Curran and E.S. Sternick</i>	
Process Control for Optimization	
Treatment Planning with the Multi-Leaf Collimator	464
<i>P.K. Kijewski and N. Maleki</i>	
New Patient Set Up in Linac-CT Radiotherapy System	465
<i>A. Akanuma, Y. Aoki, K. Sakata, M. Iio, H. Kikuchi, and H. Kawakami</i>	
Dose Distribution Evaluation in Irregular Field Multipoint Irradiation	468
<i>Y. Aoki, A. Akanuma, K. Sakata, and M. Iio</i>	
Clinical Use of a Medical Electron Linear Accelerator for Dynamic Radiation Treatments	473
<i>M.A. Henzler, L.D. Simpson, A. Perec, and B. Keller</i>	
Clinical Significance of Computer Controlled Conformation Radiotherapy — From Seven Years Experience	474
<i>T. Matsuda</i>	
Dynamic Treatment: Automation of a Multileaf Collimator	479
<i>H. Perry, J. Mantel, D.M. Vieau, D.L. Higden, and M.M. Lefkowsky</i>	
Data Capture	
Data Capture for Clinical Research Through Clinical Computer Support	482
<i>D.P. Ragan and J. Spicka</i>	
Implementation of a Multi-User Treatment Planning	486
<i>E.C. Mok</i>	
Radiotherapy Planning on a Vax-11/780 Computer	489
<i>J. Battista, C. Field, L. Santon, and R. Barnett</i>	
Multi-Institutional Radiation Therapy Computation Planning Facility	493
<i>A. Chung-Bin and S.-D. Kang</i>	
Survey of the Present State and Utilization of Apparata Related to Radiotherapy in Japan	496
<i>E. Takenaka and Y. Onai</i>	
Optimizing Computing Resources in Radiotherapy Dose Planning	500
<i>A.E. Nahum</i>	
A Radiotherapy Department Computer Database	501
<i>R.F. Curley and T.J. Smith</i>	
Patient Records for Oncology — The Pro System	506
<i>D. Shackleton, R. Sealy, and B. Domerghi</i>	
A Method of Cure Rate Estimation and Accuracy Test by Monte Carlo Method	508
<i>G. Irie and S. Ito</i>	
A Quasi-Bayesian Method for Combining <i>A Priori</i> and Sample Information on the Elements of the Parameter Vectors of Regression Models of Binomial Clinical Responses in Radiation Oncology	511
<i>D.E. Herbert</i>	
An Interactive Report Generator for Clinical and Radiation Oncology	521
<i>Y. Cohen, Y. Mohilever, M. Yudelev, and M. Tatcher</i>	
The Role of the End User in Developing Computerized Information Management Applications	524
<i>P.K. Kijewski</i>	

A Documentation System for Program Development	529
<i>P.K. Kijewski and P. Manaloor</i>	
Slit Beam Rotation Therapy with the Computer Assisted Linear Accelerator	533
<i>T. Kamada, H. Tsujii, J.-E. Mizoe, Y. Watanabe, and G. Irie</i>	
Future of Computerized Tomography in Radiotherapy and Treatment Planning	536
<i>D. Bakker and M.A. Crommelin</i>	
An Integrated Radiotherapy Computing Environment	541
<i>P. Dickof and P. Morris</i>	
Man-Machine Interface of the Medical Record Database in Radiology	544
<i>S. Ito and G. Irie</i>	
Integrated Departmental Patient Information System	547
<i>A. Chung-Bin, S. Kang, T. Wachtor, and D. Hendrickson</i>	
Program Cart — A Nordic Challenge in Medical Computing	549
<i>H. Dahlin</i>	
An Integrated Scheduling and Patient Flow Management System for Radiation Oncology	553
<i>S. Fox, J. M. Hanson, and B.D. Stoskopf</i>	
Author Index	559

Invited Papers

Treatment Planning - Past Shortfalls and Future Needs

William E. Powers, M.D.

Radiation Oncology Department, Wayne State University, Harper-Grace
Hospitals, Detroit, MI 48201

ABSTRACT

The expectation of the developers of small treatment planning computers was that 30 such units might satisfy the world demand. Now, 15 years later, approximately 1000 of these devices are in use and have become an accepted minimum standard of patient care. Despite this acceptance, additional developments will be needed in the area of: 1) Physician interaction (definition of tumor extent, desired tumor dose gradient, normal tissue doses, scores of cost benefit, administration of dose within a three dimensional patient and the ability to deliver a desired dose). 2) Patient data collection (CT input, NMR input, other). 3) Dose calculation (Three dimensional irregular fields, accurate patient models, surface dose estimates, irregular internal structures and non-photon beams). 4) Dose display (3-D display, isoeffects, complication probabilities, etc.). 5) As treatments become more complicated with multiple modalities, shaped fields, various fractionation schemes, adjuvant chemotherapy or heat, etc., computer assistance for treatment optimization is required. The physicians have sought computer assistance in order to provide more and better organized information for patient treatment planning. Much remains to be done to facilitate patient care. In addition to treatment planning, these small computer systems represent an under utilized resource within radiotherapy departments for management information and other modern information system support. Systems must be developed which tie dose calculated (prescribed) to dose delivered and ultimately, to treatment success or failure.

Applications of Computer Technology in Medicine

Jerome R. Cox, Jr., PhD

Department of Computer Science, Washington University
St. Louis, Missouri

ABSTRACT

There are several developments in computer science and engineering that may have a substantial impact on the use of computers in medicine and in radiation therapy, in particular. Perhaps the most profound is the development of microelectronic techniques that make possible the fabrication of custom chips. The opportunities and limitations of VLSI for radiation treatment planning are discussed in the context of a specialized chip that implements a new three-dimensional dose calculation. Microelectronics has made possible the economical production of raster graphics and image processing systems. The combination of these systems and picture archiving and communication systems (PACS) open a number of new possibilities in departments of radiology. Some examples of presentations that allow three-dimensional visualization will be discussed. The proliferation of microprocessor based systems has emphasized the need for portability of software. UNIX seems to be gaining sufficient popularity among the producers of 16-bit microcomputers to have achieved the status of an informal standard. Potential and problems for medicine will be discussed based on the assumption that the trend toward widespread use of the UNIX operating systems continues. Finally, developments in expert systems will be reviewed with particular attention to their possible applications in radiation therapy.