

NEUE PRODUKTE FÜR DIE QS IN DER STRAHLENTHERAPIE



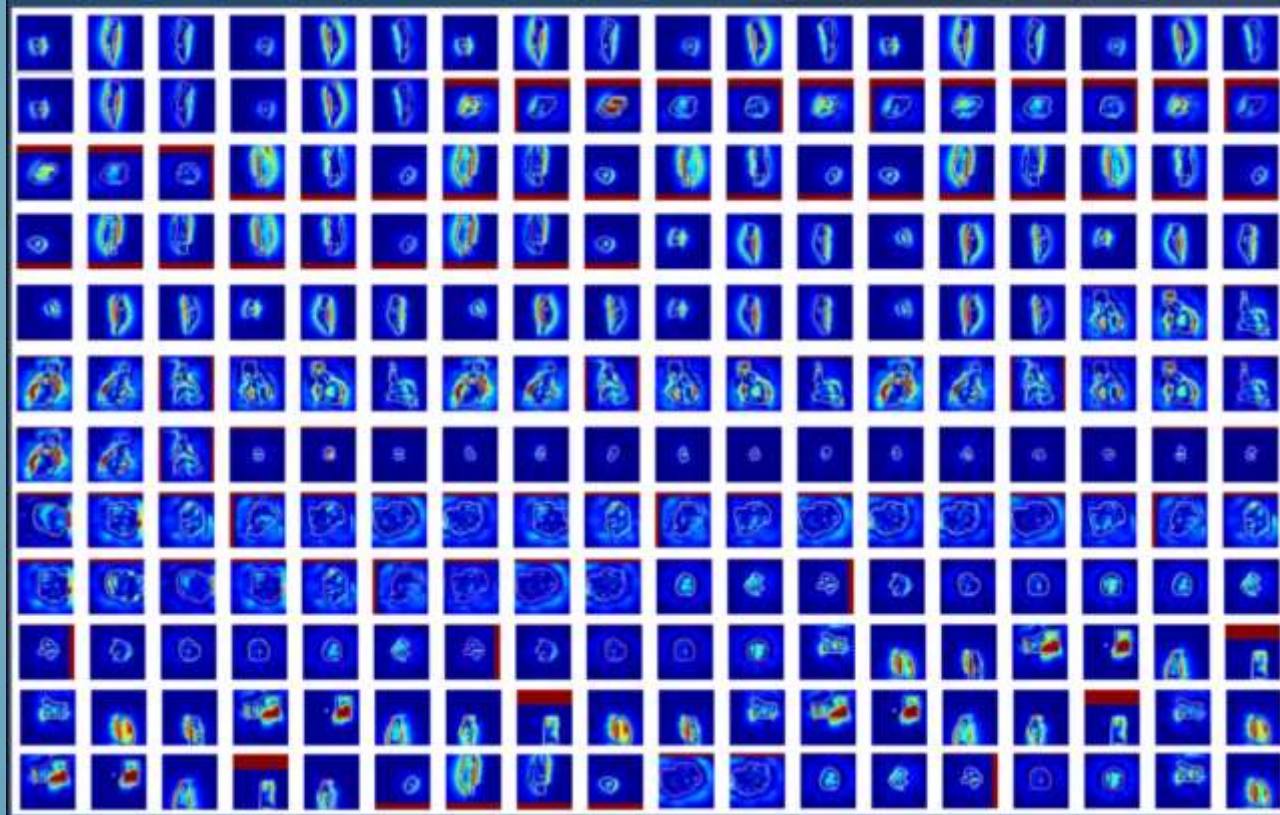
Johann Kindlein



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WIE MÖCHTEN SIE DIESE INFORMATIONEN AUSWERTEN ?



Presented by: Wolfram Laub, PhD, MBA, Director of Medical Physics
Date: January 2012



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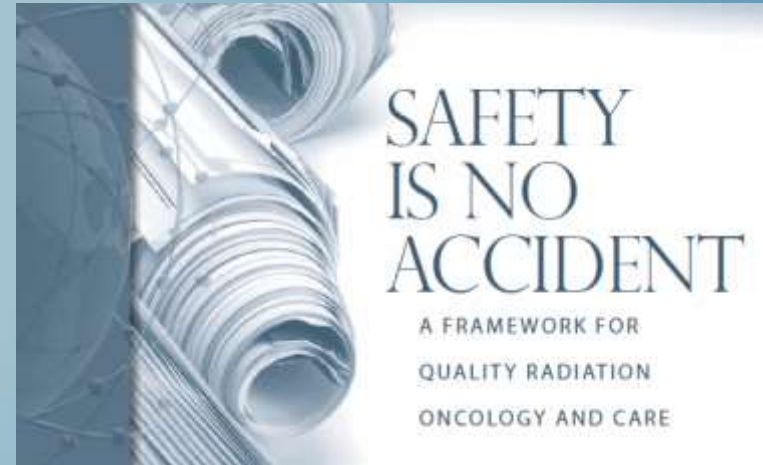
AUSSAGEN ÜBER FEHLER UND RISIKEN IN DER STRAHLENTHERAPIE

How safe is safe: Risk in radiotherapy (RT)



- Rate of misadministration in RT is 0.2 % (1 in 600)
- Rate of serious injury: airline accidents is 1 in 10 million
➢ 16,000 times lower than that of RT
- Rate of serious injury in RT is 1000 times higher
- In reality no one knows
- Risk profiles of anesthesia: similar to airline industry

Ford and Terezakis; Red Journal 78, 321-322, 2010



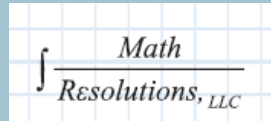
DIE DATENFLUT IM AUGE BEHALTEN



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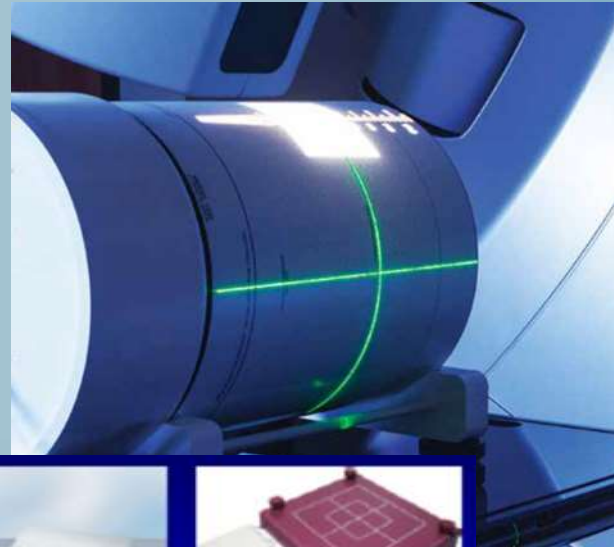
MEDINEX PRODUKTPALETTE PARTNER

1. DosimetryCheck
2. Mobius 3D
3. MobiusFX
4. FractionLab
5. DoseLab
6. EQA2
7. ADQ
8. FilmQAPro
9. OnQrts
10. ImSimQA



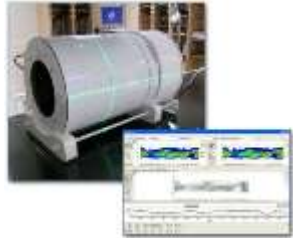
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QS IMRT - STAND DER TECHNIK



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ZEITAUFWAND FÜR IMRT QS



Hardware-Based

30-90 MINUTES

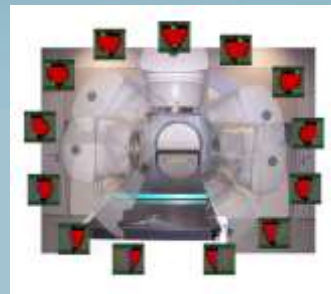




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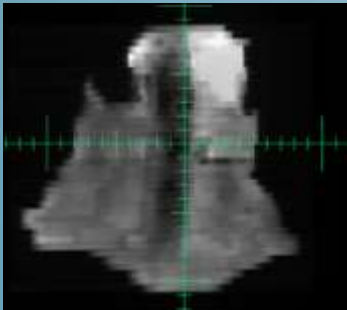
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WOHIN GEHT DIE REISE?

EPID

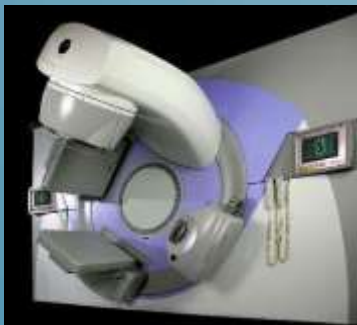
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A literature review of electronic portal imaging for radiotherapy dosimetry

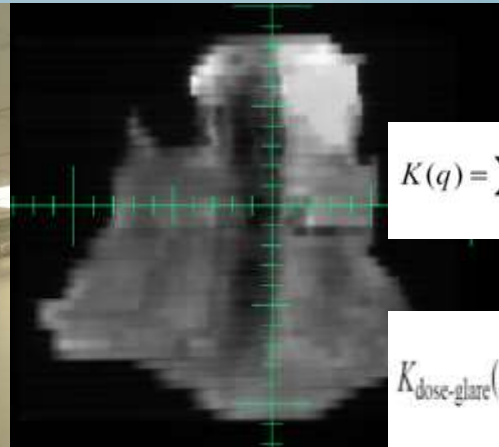
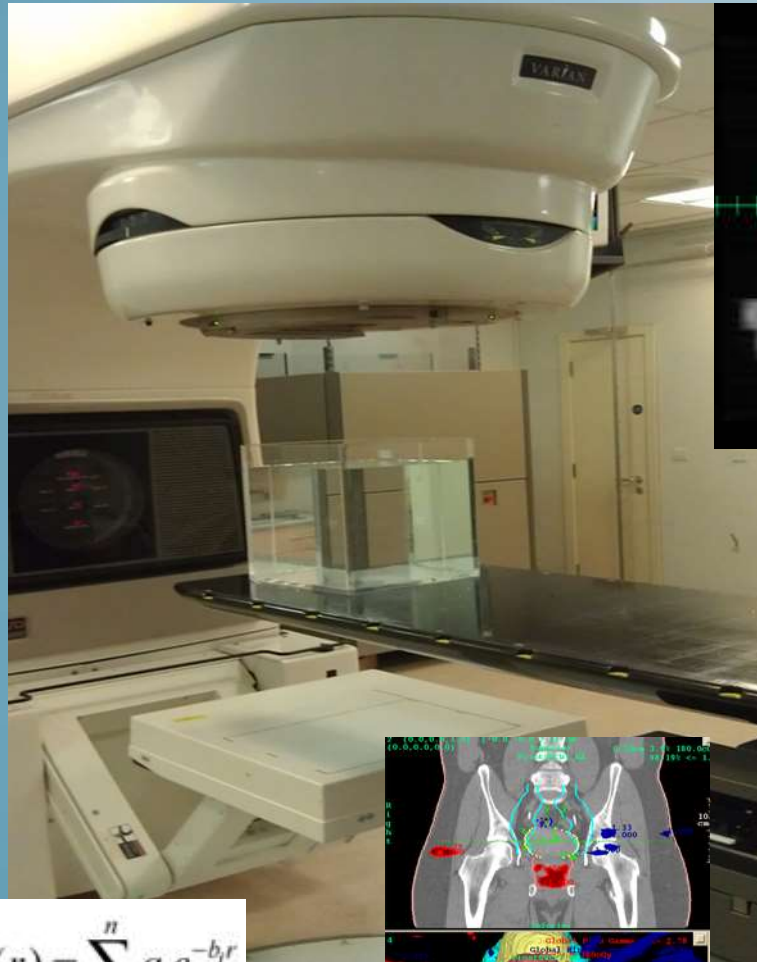
Wouter van Elmpt^{a,*1}, Leah McDermott^{b,1}, Sebastiaan Nijsten^a, Markus Wendling^b, Philippe Lambin^a, Ben Mijnheer^{a,b}



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DOSIMETRYCHECK

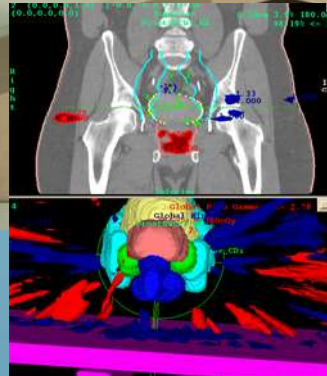
EPID 3D IN VIVO DOSIMETRIE



$$K(q) = \sum_i^n a_i \frac{2\pi b_i}{(4\pi^2 q^2 + b_i^2)^{3/2}}$$

$$K_{\text{dose-glare}}(r) = \exp(-a_1 r) + a_2 \exp(-a_3 r) + a_4 \exp(-a_5 r) + a_6 \exp(-a_7 r) + a_8 \exp(-a_9 r). \quad (7)$$

$$k(r) = \sum_i^n a_i e^{-b_i r}$$



JOURNAL OF APPLIED CLINICAL MEDICAL PHYSICS, VOLUME 6, NUMBER 4, FALL 2005

A method for deconvolution of integrated electronic portal images to obtain incident fluence for dose reconstruction

Wendel Dean Renner,¹ Kevin Norton,² and Timothy Holmes³

Math Resolutions,¹ LLC, 5975 Gales Lane, Columbia, Maryland 21045-3841; Hartford Hospital,² Dept. Radiation Oncology, 80 Seymour Street, Hartford, Connecticut 06102 and The University of Connecticut Health Center, Dept. Radiation Oncology, Room CG178, 263 Farmington Avenue, Farmington, Connecticut 06030-2930; St. Agnes Health Care,³ Dept. Radiation Oncology, 900 Caton Avenue, Baltimore, Maryland 21229 U.S.A. WendelDRenner@mathresolutions.com, knorton@uchc.edu, tholmes@stagnes.org

Received 19 January 2005; accepted 13 July 2005



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PATENTIERTE TECHNOLOGIE

(12) **United States Patent**
Renner (10) Patent No.: **US 8,605,857 B1**
(45) Date of Patent: ***Dec. 10, 2013**

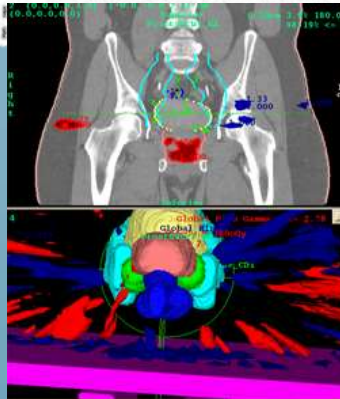
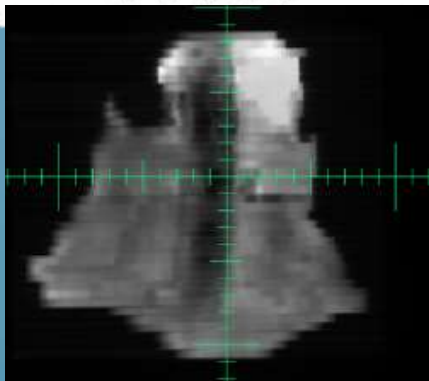
(54) METHOD AND SYSTEM TO RECONSTRUCT TREATMENT DOSE TO A PATIENT FROM INTEGRATED EXIT-TRANSIT IMAGES OF RADIATION FIELDS TAKEN DURING TREATMENT (56) **References Cited**
U.S. PATENT DOCUMENTS
5,754,622 A * 5/1998 Hughes 378/65
6,438,202 B1 * 8/2002 Olivera et al 378/65
6,636,622 B2 * 10/2003 Mackie et al 382/132

(12) **United States Patent**
Renner (10) Patent No.: **US 8,351,572 B1**
(45) Date of Patent: **Jan. 8, 2013**

(54) METHOD AND SYSTEM TO RECONSTRUCT TREATMENT DOSE TO A PATIENT FROM INTEGRATED EXIT-TRANSIT IMAGES OF RADIATION FIELDS TAKEN DURING TREATMENT (56) **OTHER PUBLICATIONS**
Wendell Dean Renner, Kevin Norton and Timothy Holmes, A Method for Deconvolution of Integrated Electronic Portal Images to Obtain Incident Fluence for Dose Reconstruction, *Journal of Applied Clinical Medical Physics*, vol. 6, No. 4, Fall 2005, pp. 22-39.
Markus Wendling, Leah N. McDermott, Anton Mans, Jan-Jacob Sonke, Marcel van Herk, and Bea J. Mignhofer, A Simple Backprojection Algorithm for 3D in vivo EPID Dosimetry of IMRT Treatments,

(12) **United States Patent**
Renner (10) Patent No.: **US 6,853,702 B2**
(45) Date of Patent: **Feb. 8, 2005**

(54) RADIATION THERAPY DOSIMETRY QUALITY CONTROL PROCESS (56) **References Cited**
U.S. PATENT DOCUMENTS
5,754,622 A * 5/1998 Hughes 378/65
6,038,283 A * 3/2000 Carol et al 378/65
6,038,284 A * 3/2000 Hernandez-Guerra et al 378/65
6,175,761 (57) **Abstract**
6,438,202 (57) **Abstract**



$$K(q) = \sum_i^n a_i \frac{2\pi b_i}{(4\pi^2 q^2 + b_i^2)^{3/2}}$$

$$k(r) = \sum_i^n a_i e^{-b_i r}$$

$$K_{\text{dose-glare}}(r) = \exp(-a_1 r) + a_2 \exp(-a_3 r) + a_4 \exp(-a_5 r) + a_6 \exp(-a_7 r) + a_8 \exp(-a_9 r). \quad (7)$$

JOURNAL OF APPLIED CLINICAL MEDICAL PHYSICS, VOLUME 6, NUMBER 4, FALL 2005

A method for deconvolution of integrated electronic portal images to obtain incident fluence for dose reconstruction

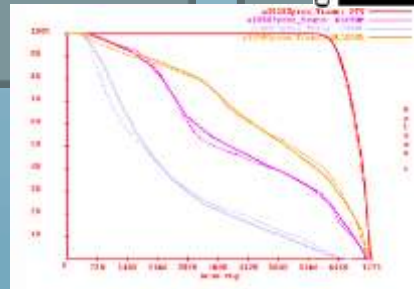
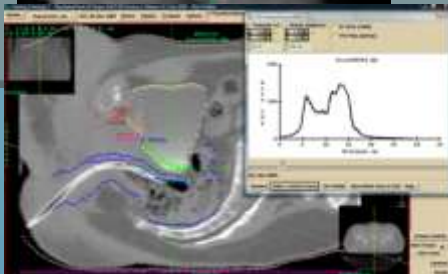
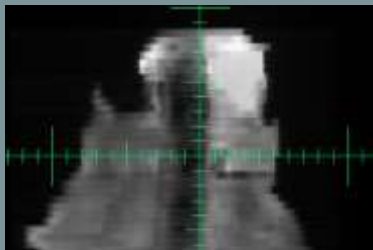
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EPID 3D „PRE-TREATMENT“ UND TRANSIT IN VIVO DOSIMETRIE FÜR IMRT, VMAT UND TOMO



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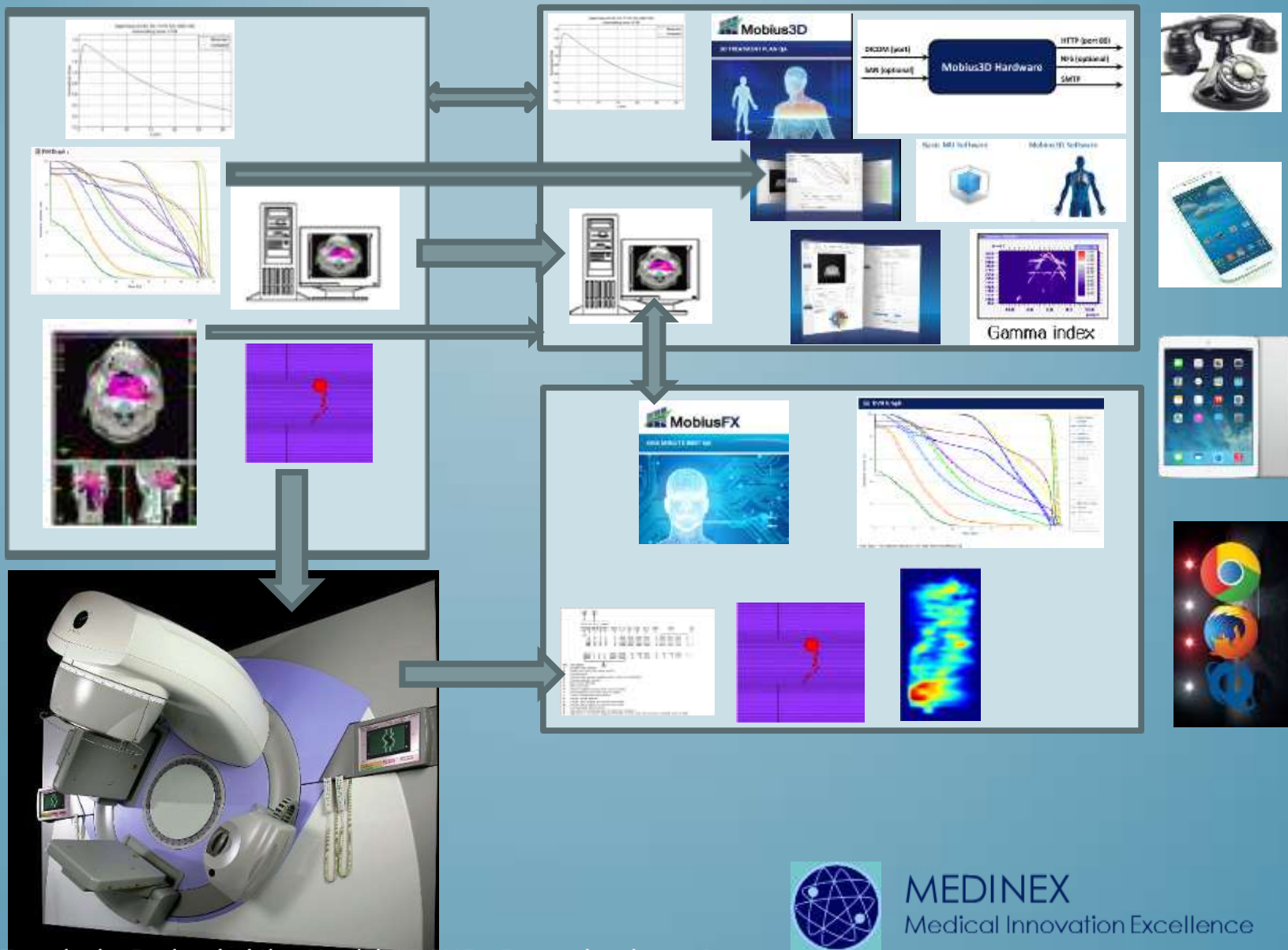
DOSIMETRYCHECK

- 1 NO EQUIPMENT SET UP REQUIRED FOR PRE-TREATMENT QA
- 2 TRANSIT IN-VIVO and PRE-TREATMENT PATIENT DOSIMETRY
- 3 INDEPENDENT MEASURED DOSE CALCULATIONS with & without the patient in the Beam
- 4 PROVIDES 2-D and 3-D ANATOMICAL DOSE RESULTS ANALYSES of:
- 5 PRE TREATMENT and ON TREATMENT IN-VIVO MEASUREMENTS of PATIENTS
- 6 MEASURED DOSE VERIFICATION USING PATIENT CT DATA SET
- 7 WORKS WITH: ANY RTP SYSTEM
- 8 STRUCTURE ANALYSIS: 3D DOSE VOLUME HISTOGRAMS (DVHs) &
- 9 GAMMA VOLUME HISTOGRAMS (GVHs)
- 10 3D PREDICTED (PLANNED) VS. ABSOLUTE DOSE (MEASURED) ANALYSIS
- 11 SUPPORTS: Conventional IMRT, VMAT, RapidArc and MORE
- 12 WORKS WITH: Elekta iView Portal Imager, Varian's Portal Vision, R and E Arm Portal Imager's and Siemens Optiview Portal Imager



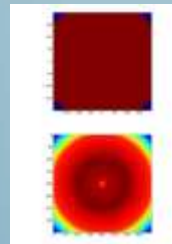
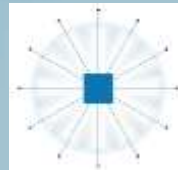
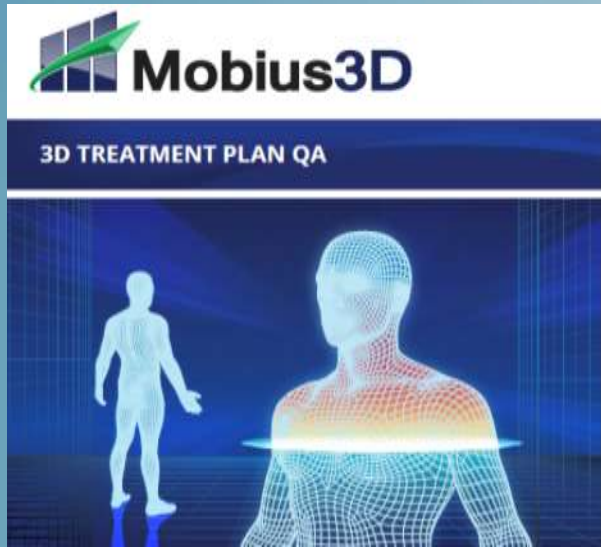
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MOBIUS 3D UND MOBIUS FX



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MOBIUS 3D AUF EINEN BLICK



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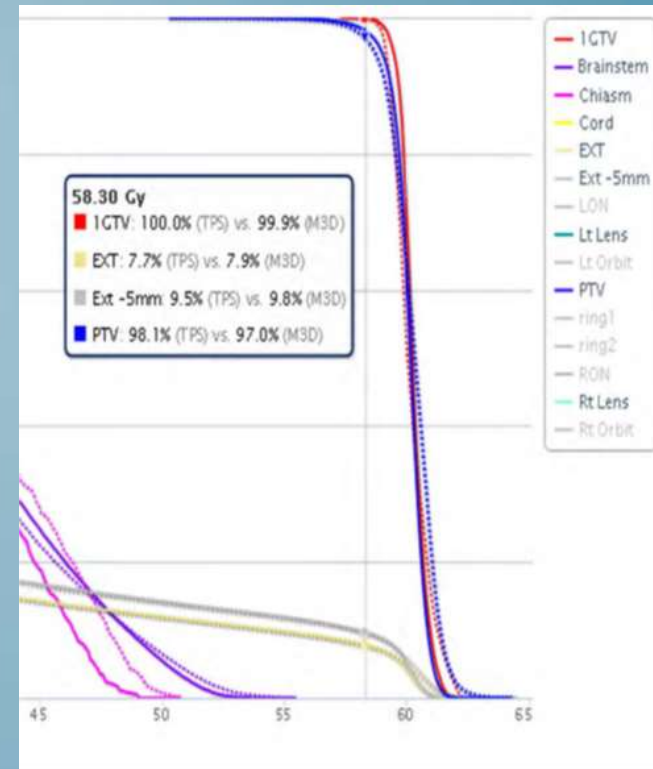
MOBIUS 3D – KEY FEATURES

Mobius 3D

Das automatische System für 3D- Bestrahlungsplanung QA

Key Features

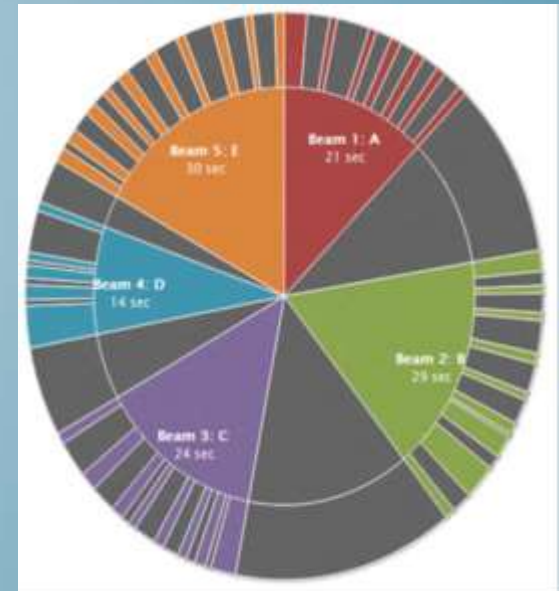
- ✓ 3 % Genauigkeit für IMRT & VMAT Anwendungen mit komplexer Anatomie
- ✓ PlugIn -Einsatzbereitschaft
- ✓ Kein Zeitaufwand
- ✓ Automatischer Start mit minutenschnellen GPU Berechnungen
- ✓ Voreinstellungen der Server-Funktionen
- ✓ Voreinstellungen der Schnittstellen Ihrem Planungssystem und Linearbeschleuniger
- ✓ Unabhängiger schneller „Collapsed-Cone Faltungsüberlagerungs (CCCS)-Algorithmus“
- ✓ Gold Standard „Commissioning-Beam – Modell“ zur Überprüfung die Ihrer Messdaten
- ✓ Automatisches Importieren der DICOM RT Planungsdaten.
- ✓ Verwendung der Planungs-CT Daten für die Berechnungen
- ✓ Automatische Kontrolle der DVH Zielvolumen
- ✓ Überprüfung der Dosis im gesamten Patientenbehandlungsvolumen
- ✓ MU Prüfung in mehr als einem einzigen Punkt (3D)
- ✓ Patienten Heterogenitäten werden automatisch mit den CT- Daten berücksichtigt
- ✓ Überprüft ob die DVH-Ziele Ihrer Pläne erfüllt werden
- ✓ Berechnung der 3D-Passing Rate



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MOBIUS 3D – KEY FEATURES

- ✓ 3D Gamma-Analyse in einzelnen CT-Schnitten (Transversal, Koronar, Sagital)
- ✓ Individuelle ROI-Einstellungen mit Identifizierung der anatomischen Strukturen.
- ✓ Einstellung individueller Toleranzen für Warnungen
- ✓ Streu-Voxel Erkennung in den Zielstrukturen Verhinderung falscher Dosisberechnungen
- ✓ Vorinstallierte DVH Zielvorgaben von RTOG und TG -101 DVH
- ✓ PDF- Reports für die Planungsdaten jedes Patienten
- ✓ Intuitive Browser-Schnittstellen und Bedienung
- ✓ Browser Zugang von Laptops, Tablets und Handys
- ✓ Kompatibel mit jedem modernen Bestrahlungsplanungssystem
- ✓ Kompatibel für konventionelle Beschleuniger und Tomo-Geräten
- ✓ Benutzer Verwaltung, Zugangsberechtigungen und Passwörter Für Physiker und Ärzte.
- ✓ Überprüfung der MLC Funktionalität (Bewegungsfähigkeit) (wie das gemacht wird ?)




MOBIUS 3D – KEY FEATURES

- ✓ Überprüfung der Kollisionsgefahr zwischen Gantry und Patient
- ✓ Bestimmung der benötigten MLC Zeiten und der Bestrahlungszeit
- ✓ Behandlungsarten
 - Photonen
 - Elektronen - Pencil Beam Neuredefinition Algorithmus (PBRA)
 - Alle Energien
 - SRS / SBRT (MLC)
 - ARCS & VMAT IMRT
 - Free Flat Filter (FFF)
 - Keil-Einschübe (Physical , Dynamic, Universal)
- ✓ Bestrahlungsplanungssysteme (TPS)
 - Pinnacle
 - Eclipse
 - XIO
 - iPlan
 - RayStation
 - Masterplan
- ✓ Multileafkollimatoren
 - Millenium Series
 - BrainLab m3
 - Strahl Modulator
 - Siemens 160 ML
 - HD 120
 - MLC i2
 - Optifocus


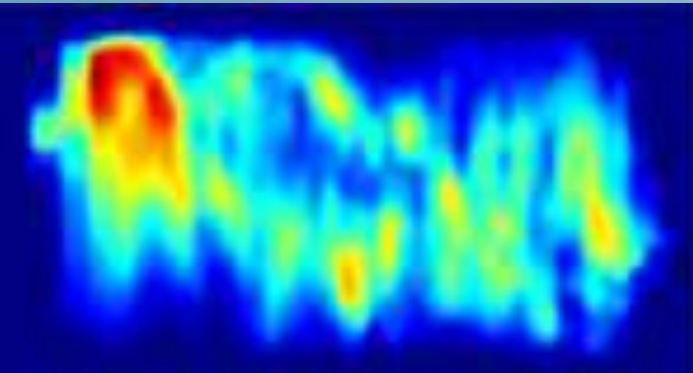
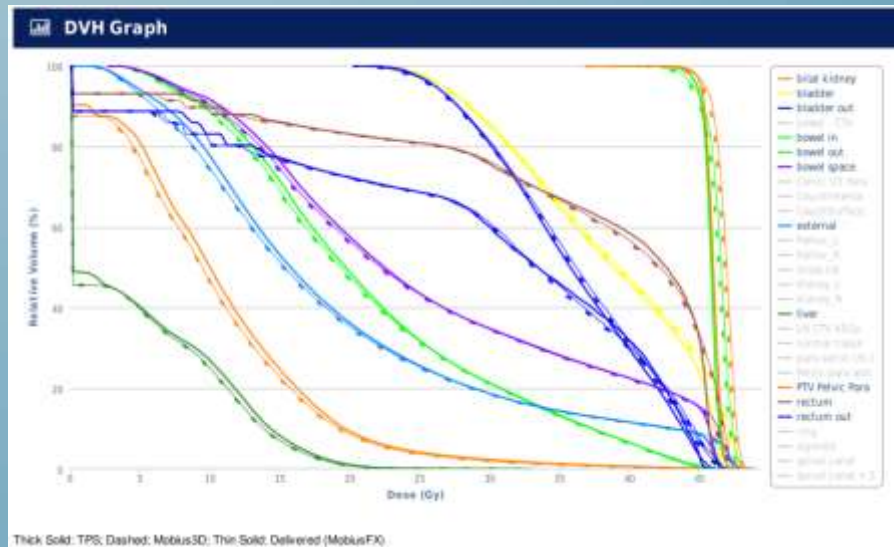


MOBIUS FX



MobiusFX

ONE MINUTE IMRT QA

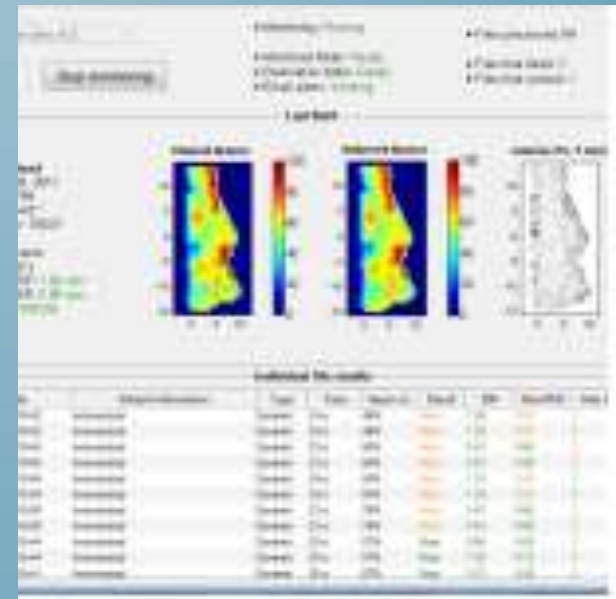
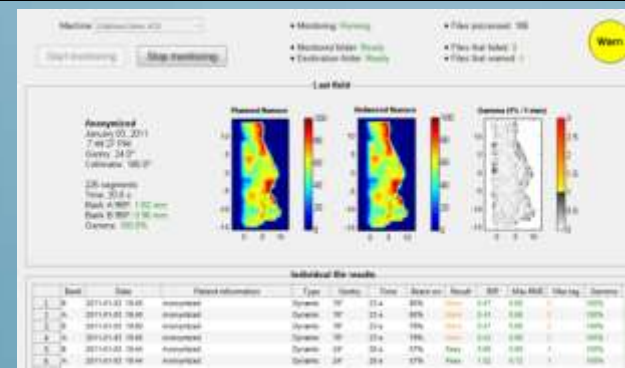
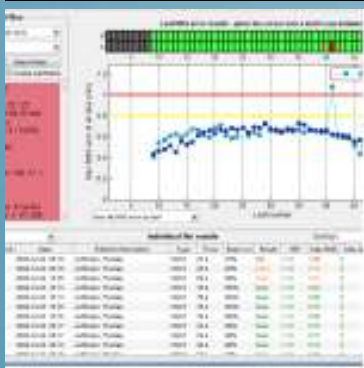
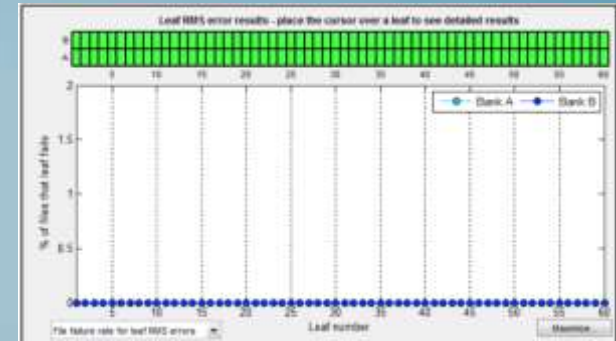
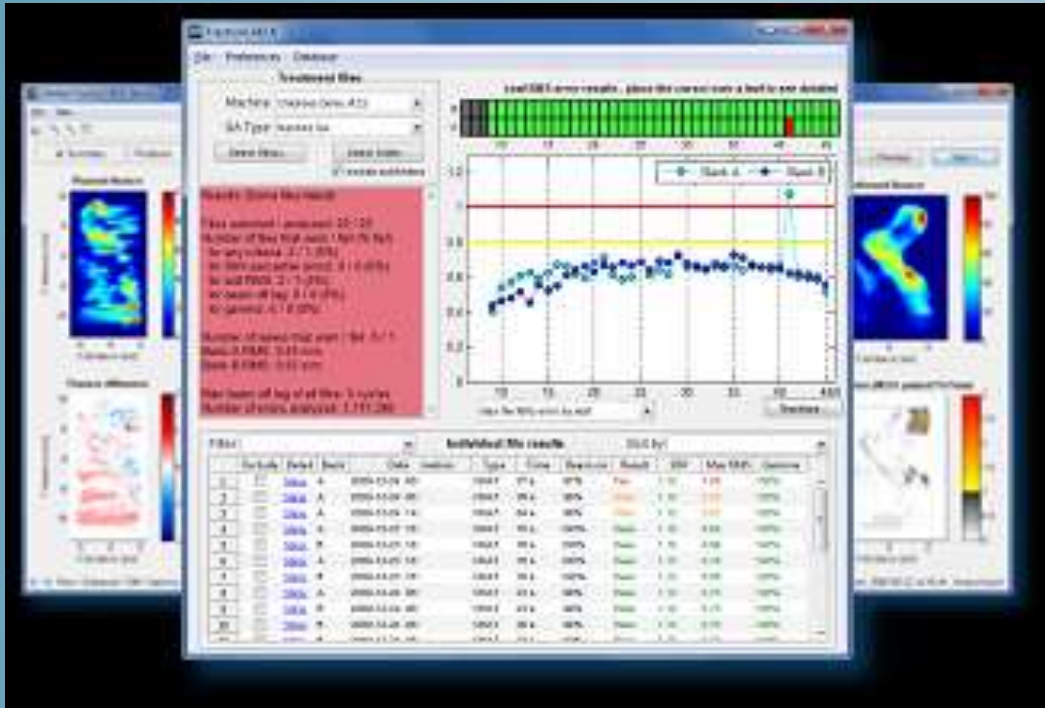
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MOBIUS FX - KEY FEATURES

- ✓ Keine Hardware erforderlich
- ✓ Kein selbständiges System. Verwendet die Mobius3D Software Module und Hardware
- ✓ Analysiert und überprüft die Funktion jedes einzelne Leaf des MLC-Kolimators
- ✓ Patienten Heterogenitäten werden automatisch mit den CT- Daten berücksichtigt
- ✓ Erkennung von Übertragungsfehler oder „Beam Commisioning“ Fehler
- ✓ 3D Kontrolle der dem Patienten verabreichte Dosis
- ✓ Überprüft ob die DVH-Ziele Ihrer Pläne erfüllt werden
- ✓ 30-90 Minuten Zeitersparnis pro Patient für Überprüfung der Bestrahlung
- ✓ Berechnung der 3D-Passing Rate
- ✓ 3D Gamma-Analyse in einzelnen CT-Schnitten (Transversal, Koronar, Sagital)
- ✓ Individuelle ROI-Einstellungen mit Identifizierung der anatomischen Strukturen.
- ✓ Einstellung individueller Toleranzen für Warnungen
- ✓ Streu-Voxel Erkennung in den Zielstrukturen Verhinderung falscher Dosisberechnungen
- ✓ Vorinstallierte DVH Zielvorgaben von RTOG und TG -101 DVH
- ✓ PDF- Reports für die Planungsdaten jedes Patienten
- ✓ Intuitive Browser-Schnittstellen und Bedienung
- ✓ Browser Zugang von Laptops, Tablets und Handys



FRACTION LAB

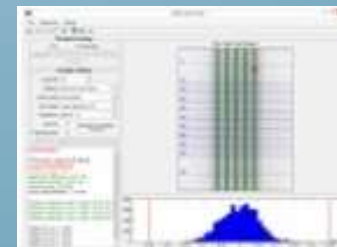
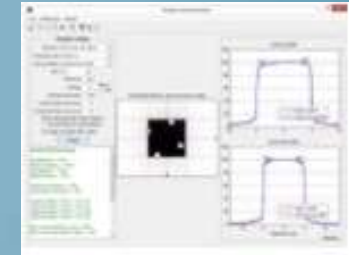
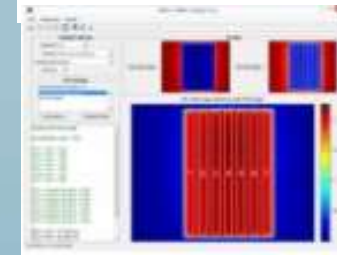
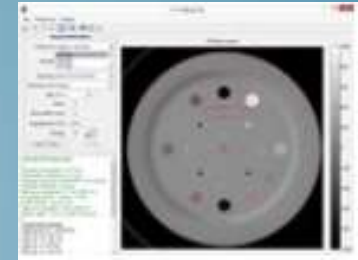
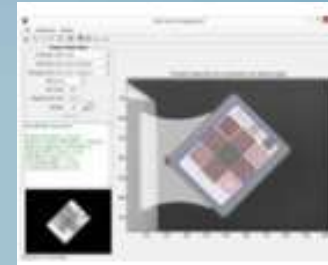


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DOSELAB



POWERFUL TG-142 QA



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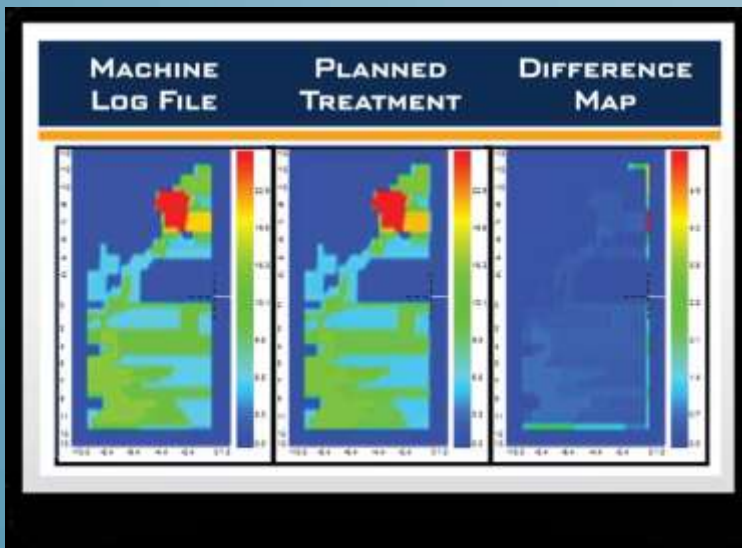
ADQ



ADQ

Key Features

- Automated comparison of machine log files to planned deliveries
- Administrative reports document delivery QA every day... automatically
- Compatible with **Varian Dynalog** and TrueBeam Trajectory log files
- Simple and Intuitive web-based user interface
- Create user accounts and manage access privileges
- Audit feature monitors and tracks all configuration changes
- No external hardware required
- **SQL database for archiving results**
- Automated message center for emailing comparison and summary reports
- **Produce daily, weekly and monthly summary reports**
- Generate on-demand administrative and comparison reports
- Configure Pass/Warning/Fail tolerances



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EQA2

Key Features



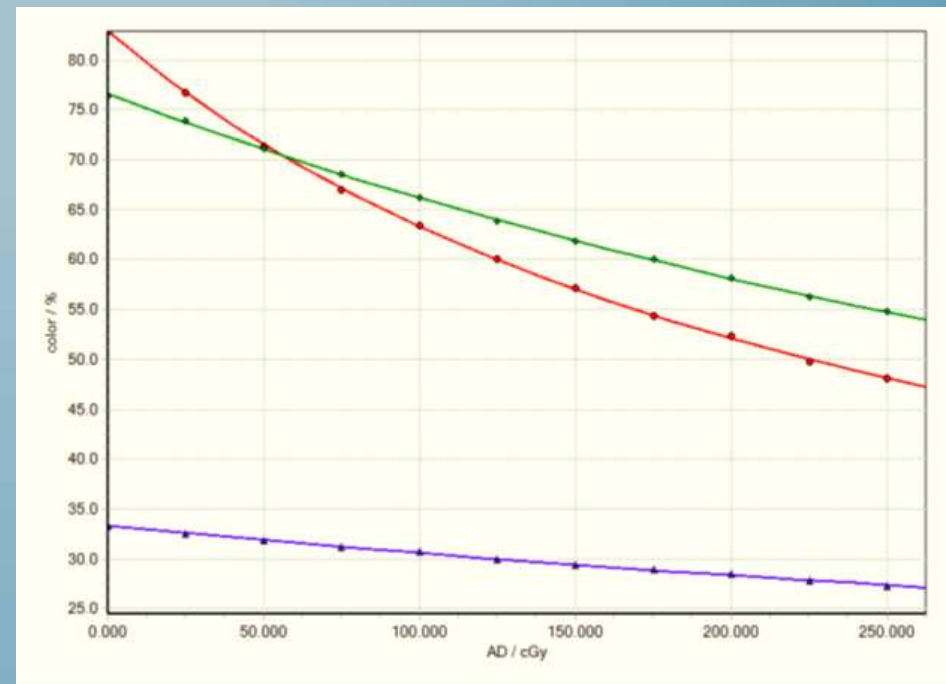
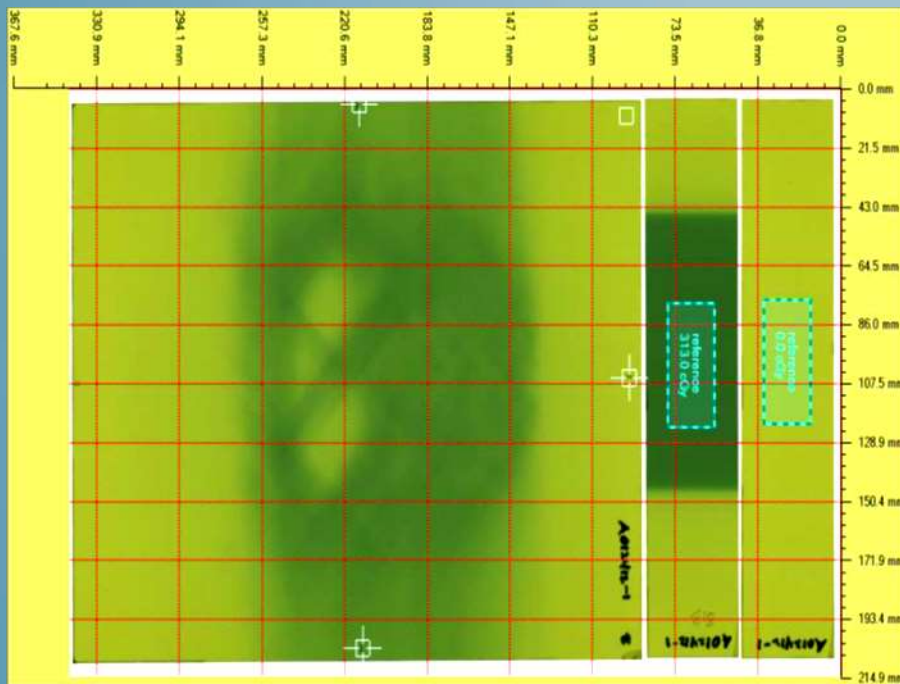
- Analyzes TG142 recommended Machine QA tests automatically
- Create custom QA forms to archive and trend data
- Perform Trend Analysis to track and identify patterns in QA
- Image analysis runs unattended in the background
- Supports multiple user levels for controlled access and security
- Flexible software architecture enables distributed use and remote access
- Receive detailed up-to-date activity across the network from the QUASAR™ Message Centre
- Organize your QA process with the QA scheduler
- Supports CITRIX-enabled thin clients with unlimited installations



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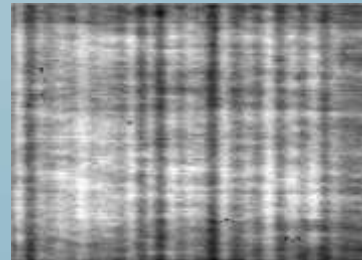
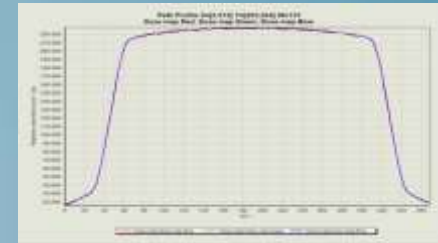
FILMQAPRO

“One Scan Triple Channel Dosimetry”
Schnell und Sicher Dreifachmessung (RGB)



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PHYSIK UND AUSWERTUNG

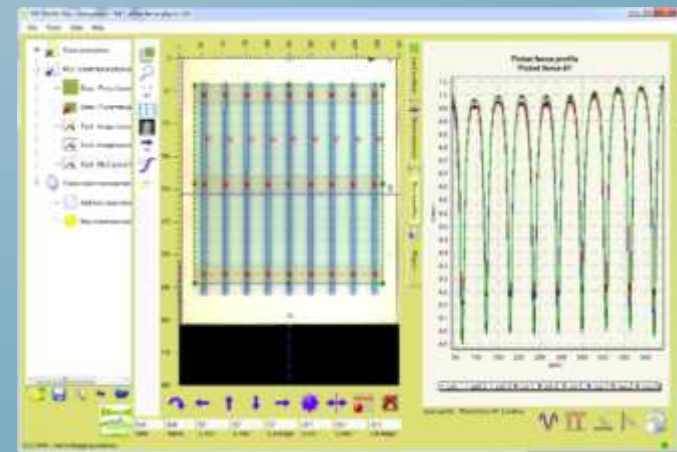
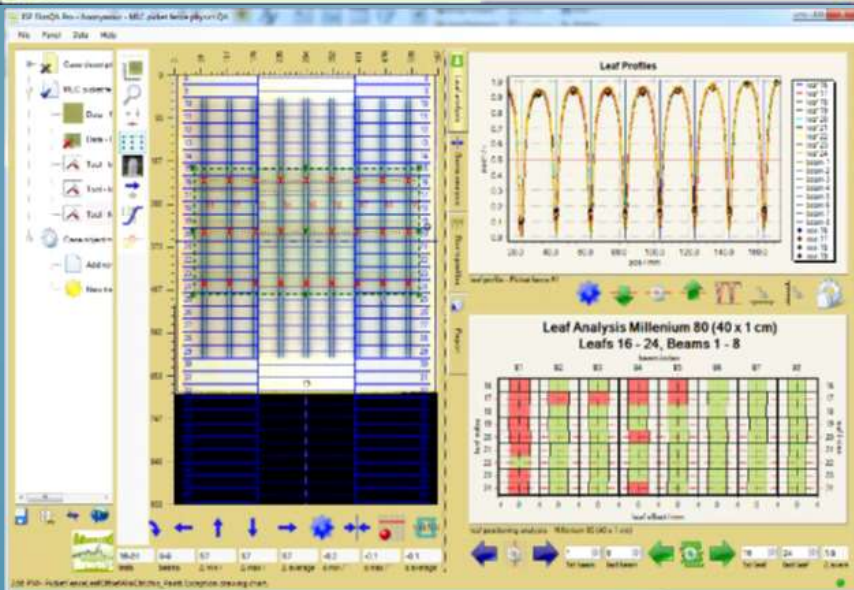
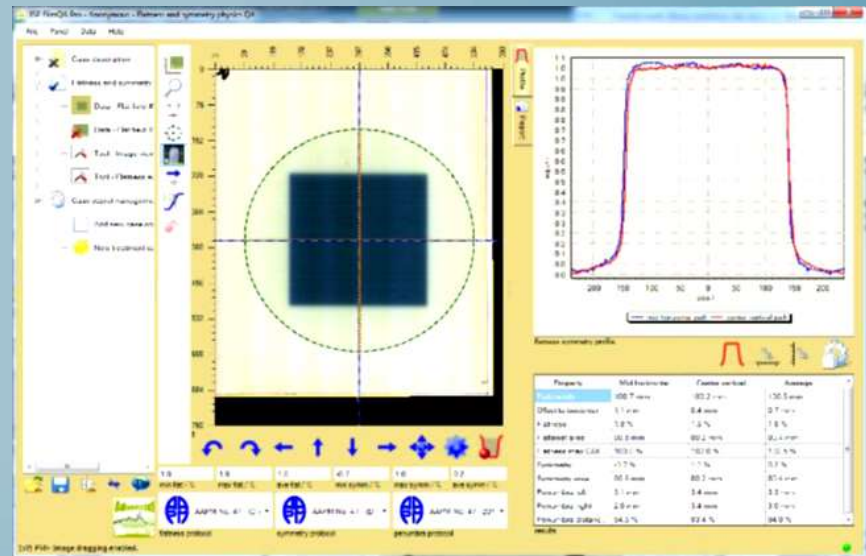
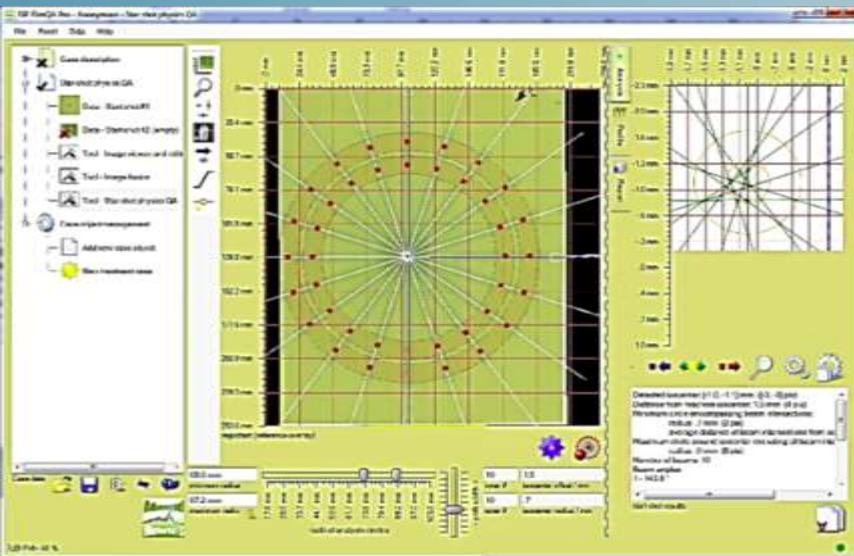


$$(\Delta d) = (DR - DB)^2 + (DB - DG)^2 + (DG - DR)^2$$

Durch Optimierung (Δd) werden
Störungsfaktoren für die Bestimmung der Dosis
ausgeschlossen



FILMQAPRO QS TOOLS



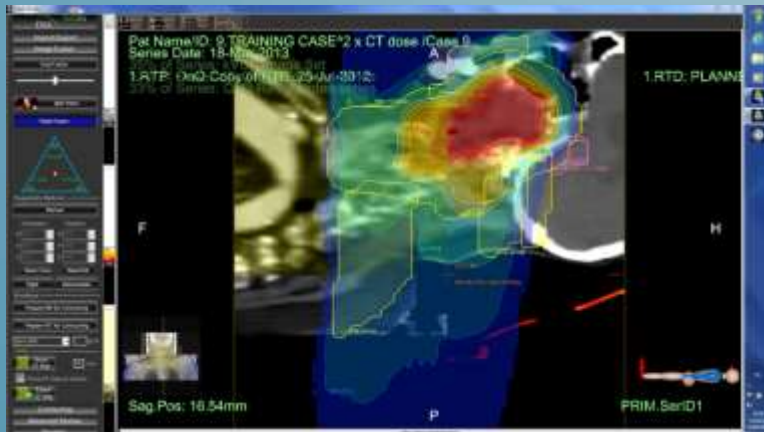
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ONQ_{RTS} - MULTIMODALES BILDVERARBEITUNGSSYSTEM



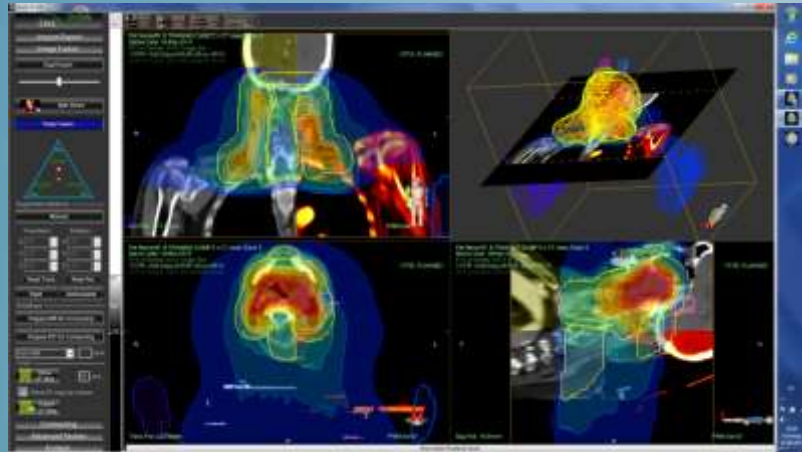
RIR und DIR Registrierungen

- Dreifach Fusionierungen:
 - CT-MR
 - CT-PET
 - CT-CBCT
 - CT-MVCBCT
- Autosegmentierungen mit anwenderspezifischen Atlas Informationen.
- Individuelle Atlas Segmentierung
- Umwandlung von Isodosen in „Structure Set“, mit Re-Import in das Bestrahlungssystem.
- Deformierbare Anpassung der Planungsdaten mit CBCT Daten und Bewertung einer möglichen Neuplanung

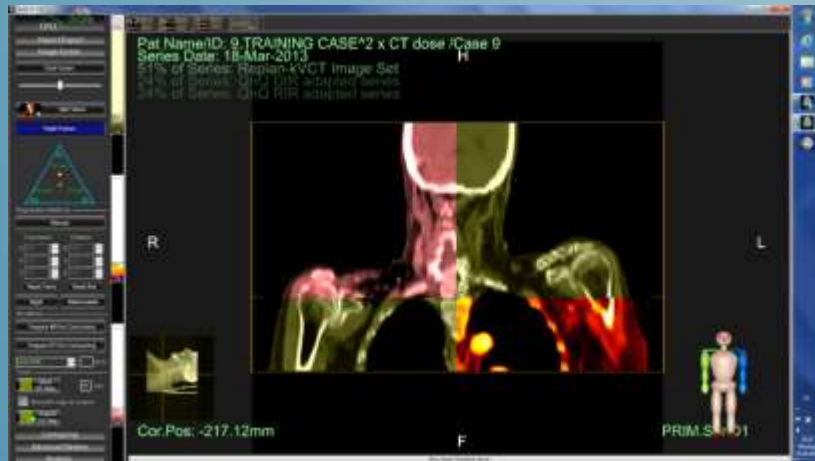


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ONQ_{RTS} - MULTIMODALES BILDVERARBEITUNGSSYSTEM

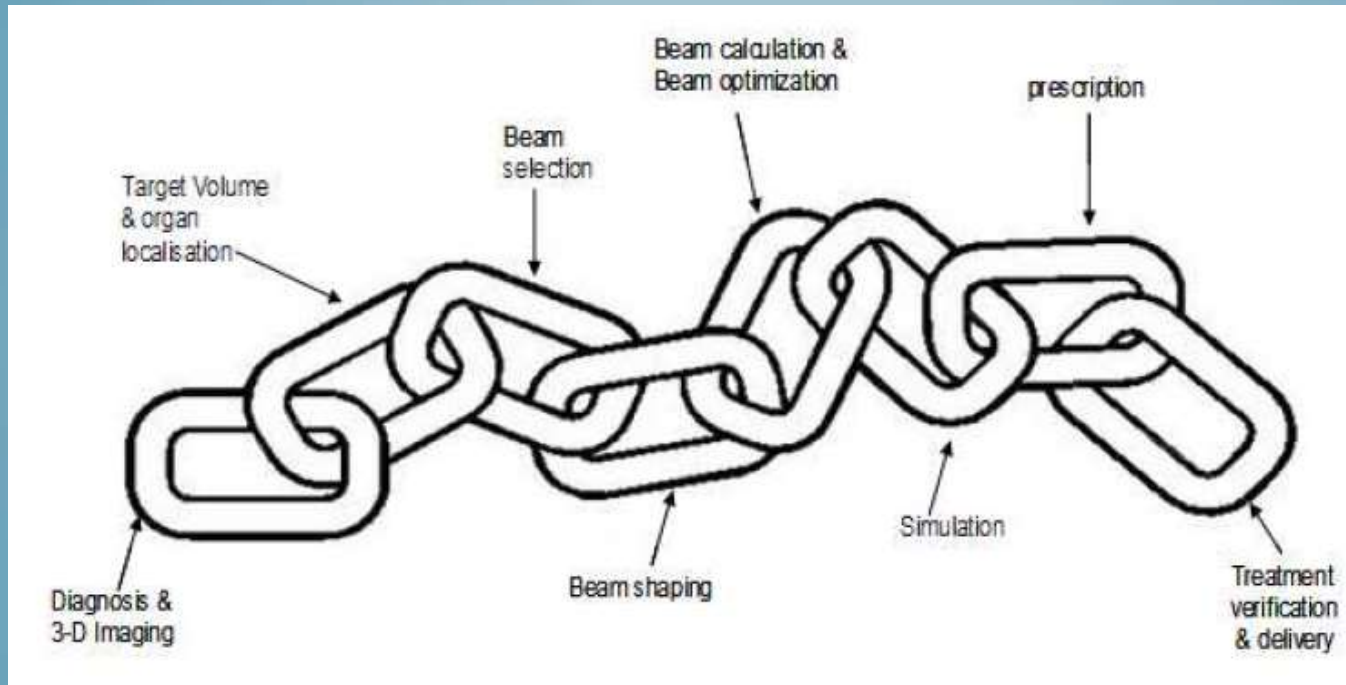


- Verhinderung aufwendiger Neuplanungen
- 4D Phasensegmentierungen
- Quantitative Evaluierung von Organ und Tumorkonturen
- Umplanungen werden erleichtert und Umplanungszeit wird verkürzt
- Nachbestrahlungen und Zusammenfügen von vorheriger Bestrahlungsplänen mit dem aktuellen Plan.
- Planadaptation bei anatomischen Veränderungen
- Festlegung von Sicherheitssäumen
- Time Scheduler
- Detaillierte Plananalyse



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IN WELCHEM GLIED DER KETTE KANN EIN FEHLER SEIN ?



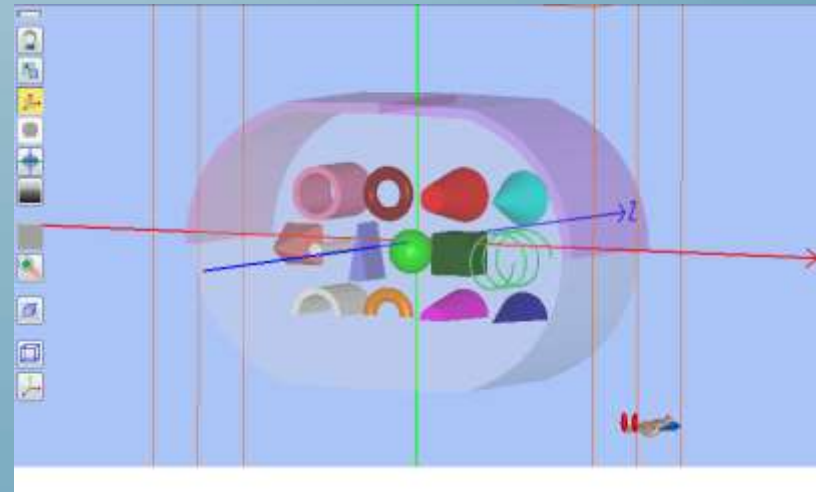
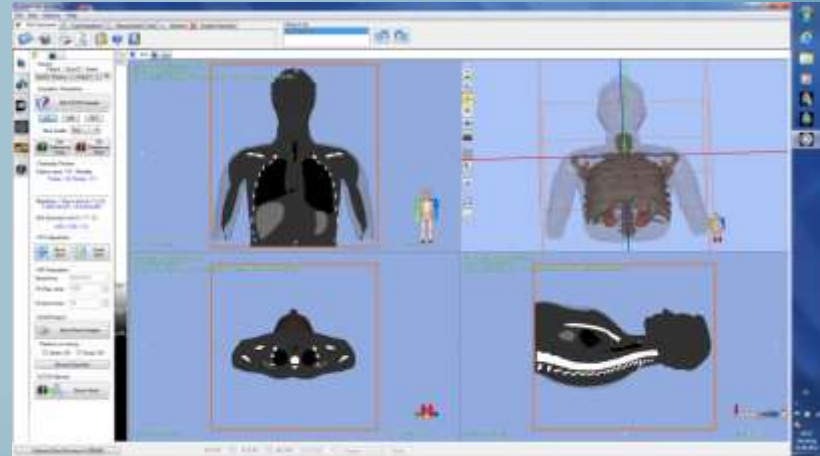
Kavuma, Awusi (2011) *Transit dosimetry based on water equivalent path length measured with an amorphous silicon electronic portal imaging device.*
PhD thesis.



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IMSIMQA - VIRTUELLE PHANTOME FÜR DIE QS DER STRAHLENTHERAPIEKETTE

QS von Bildregistrierungsmodalitäten



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**VIELEN DANK FÜR IHRE
AUFMERKSAMKEIT !**



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