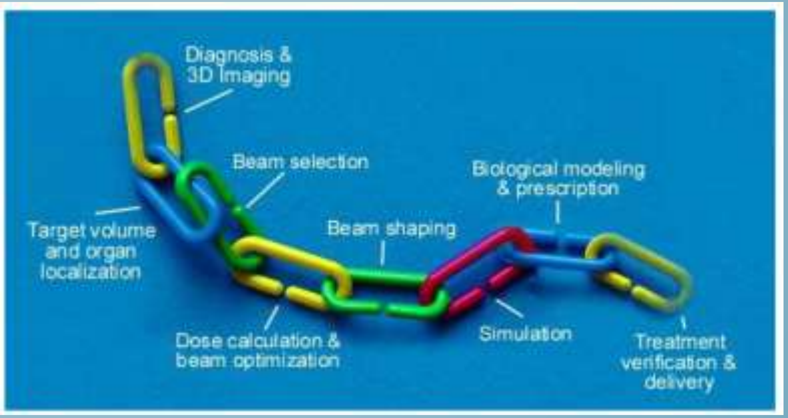
Qualitätssicherung atemgesteuerten Strahlentherapie bewegter und deformierbarer Organstrukturen

Softwarelösungen
Echtzeit Positionsbestimmungen des Tumors
Messphantome



Johann Kindlein

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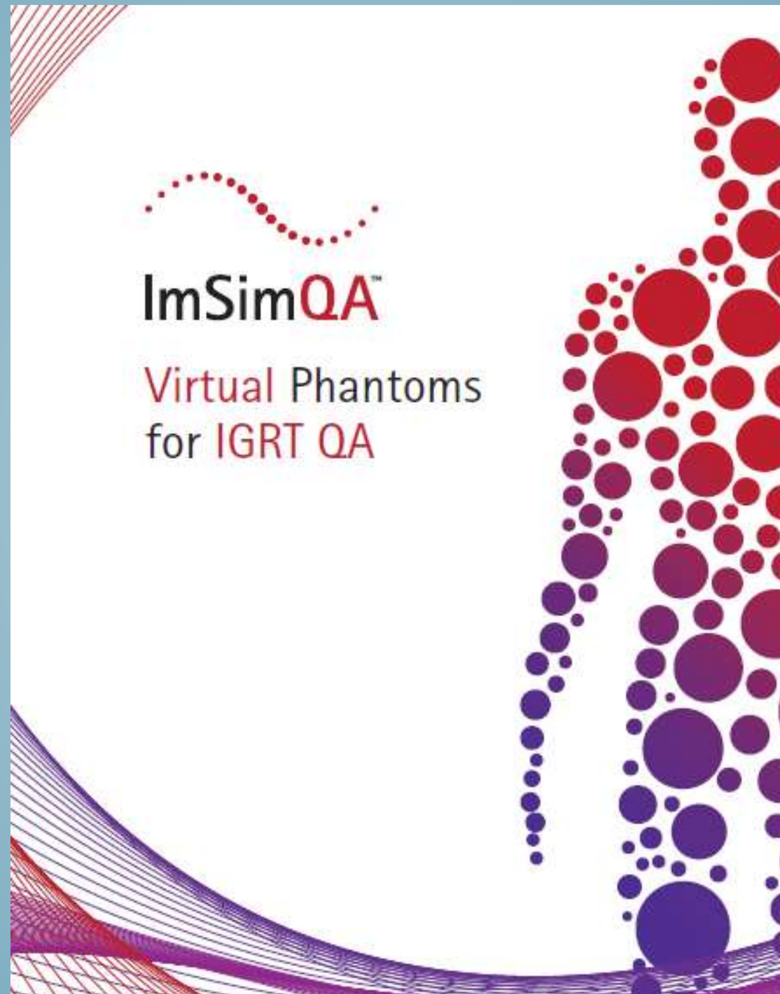
www.medinex.com.de

Arbeitskreis IMRT der DGMP Leipzig, 30-31.05.2016

SOFTWARE LÖSUNGEN

ImSimQA
Mobius3D - CBCT

QS DEFORMIERBARER KÖRPERSTRUKTUREN MIT IMSIMQA SOFTWARE PAKET



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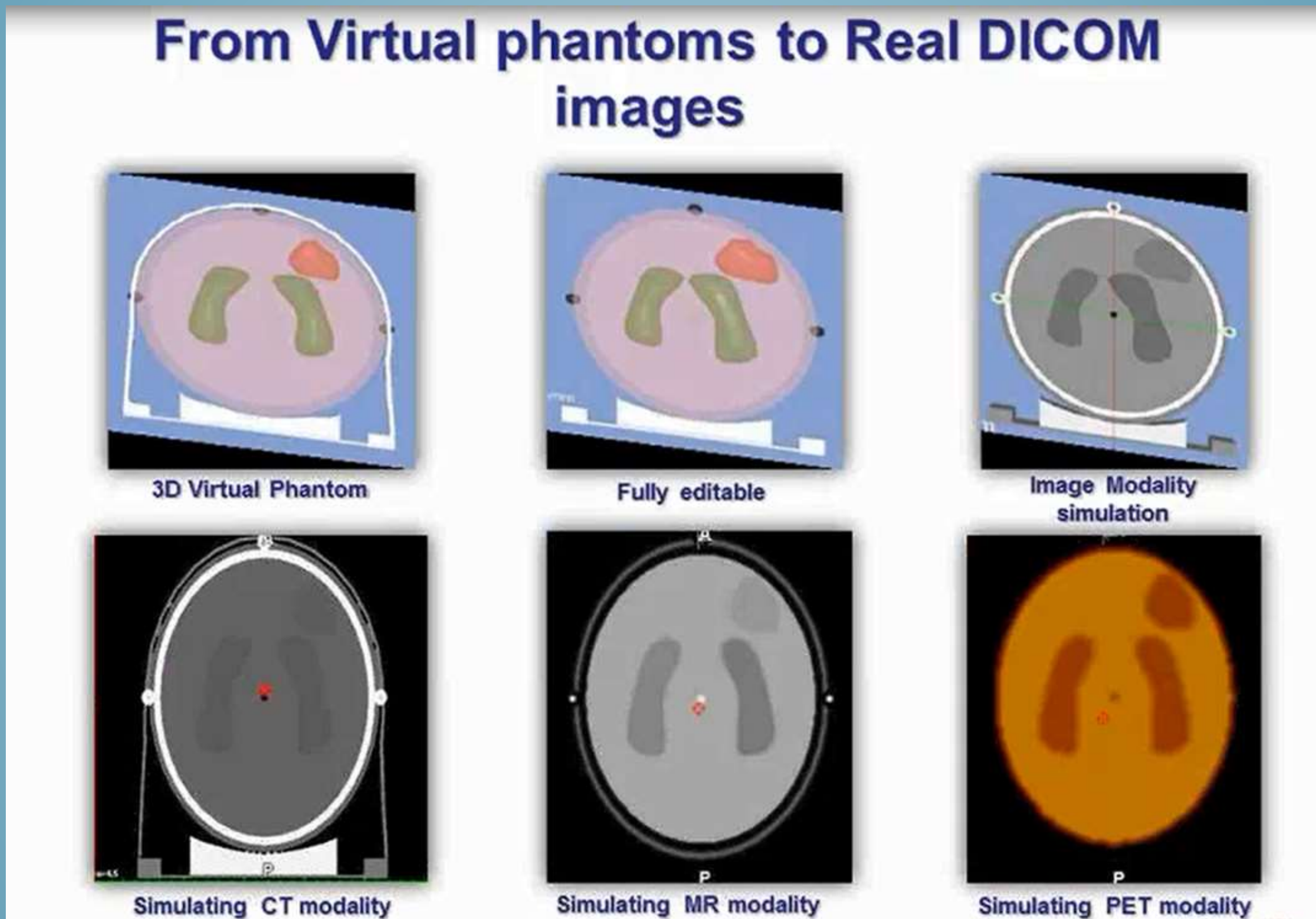
Arbeitskreis IMRT der DGMP Leipzig, 30-31.05.2016

AUS VIRTUELLEN PHANTOMEN ERSTELLUNG VON DICOM BILDDATENSÄTZEN FÜR CT, PET UND MRT



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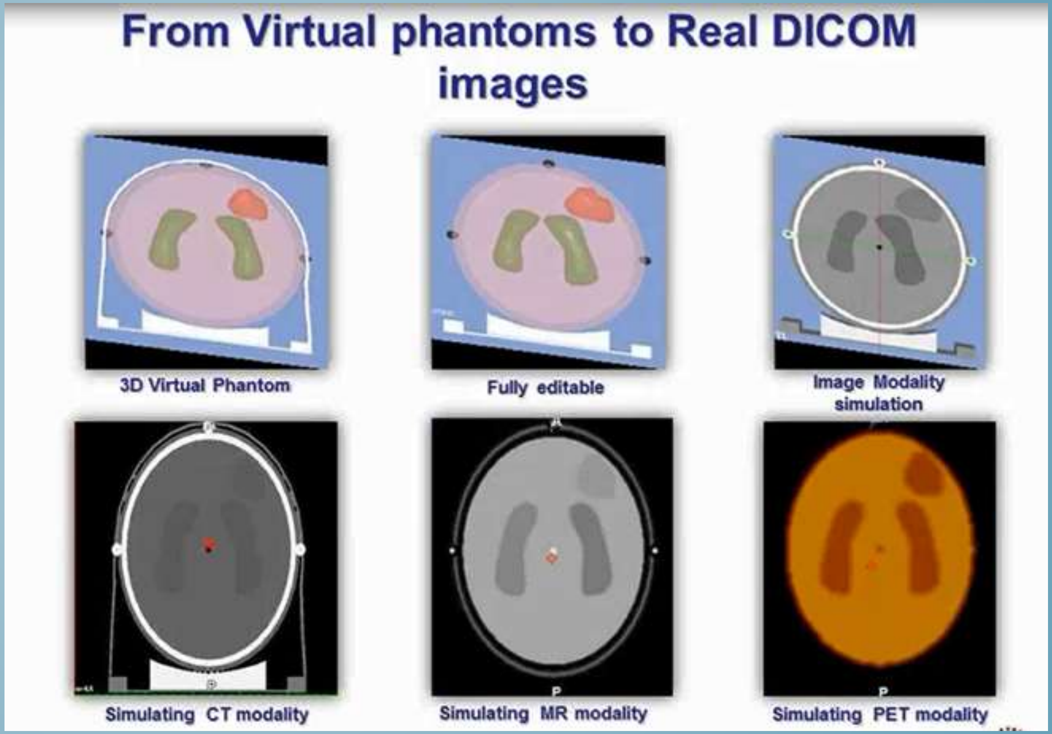
WARUM VIRTUELLE PHANTOME ?

Bekannte Parameter

- Geometrische Größen
- Definierte Deformationen
- Definierte Störeinflüsse



Standardisierte Test Bedingungen

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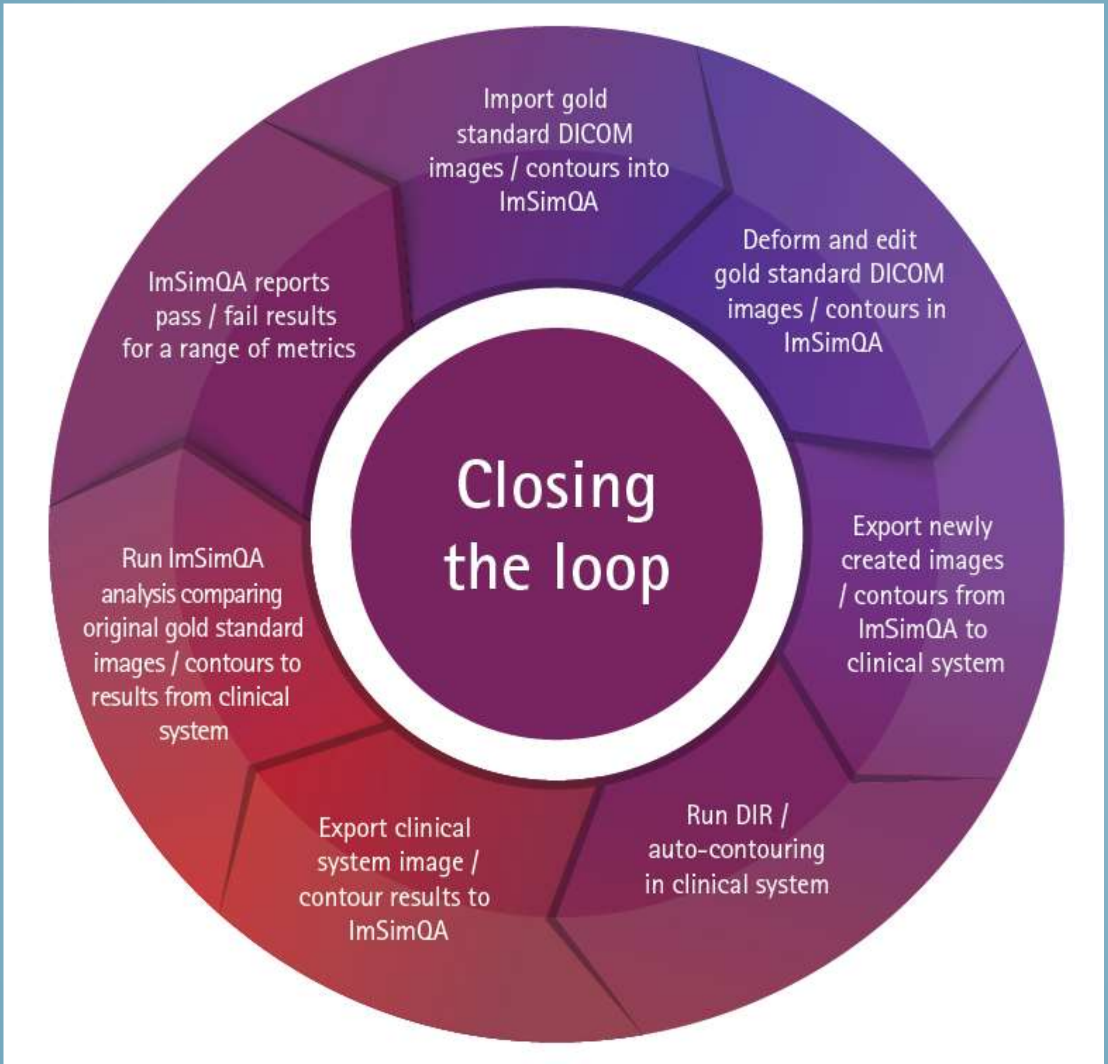
MIT IMSIMQA ZUR QS IHRER REGISTRIERUNGSALGORITHMEN



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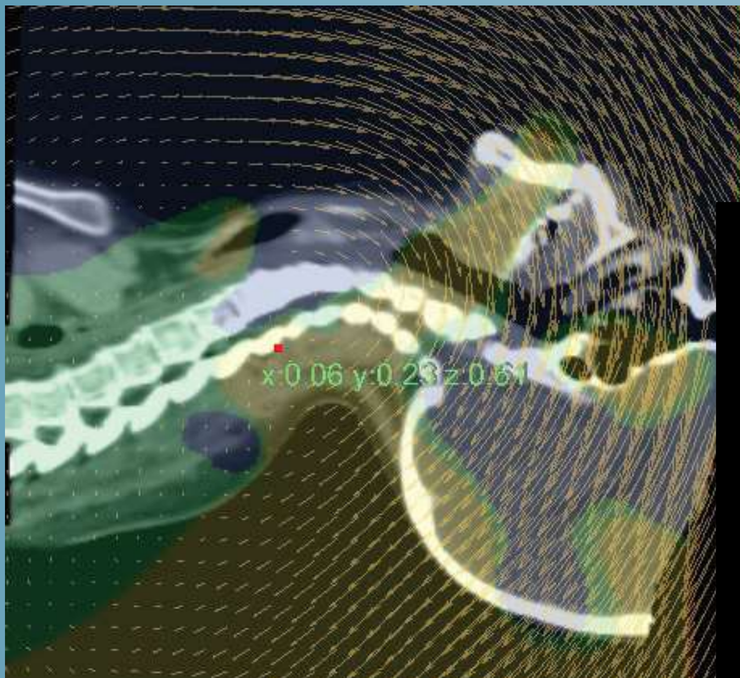
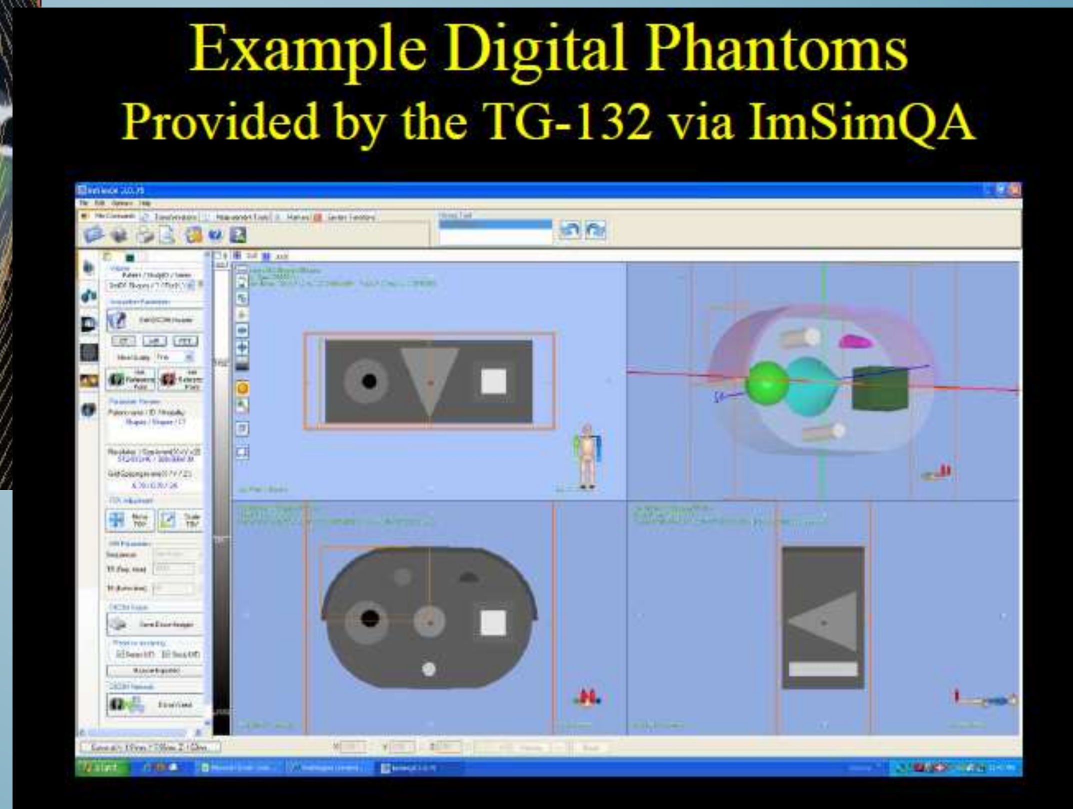
TG-132 DIE ZUKÜNFTIGE NEUE EMPFEHLUNG FÜR DIR/RIR QUALITÄTSSICHERUNG





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TASK GROUP TG – 132

Use of Image Registration and Fusion Algorithms and Techniques in Radiotherapy

Preliminary Recommendations from TG 132*

Kristy Brock, Sasa Mutic, Todd McNutt, Hua Li, and Marc Kessler

*Report is currently under review by AAPM

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TG-132 AUFGABENSTELLUNGEN

Task Group Charge

1. Review the existing techniques and algorithms for image registration and fusion
2. Discuss issues related to effective clinical implementation of these techniques and algorithms in a variety of treatment planning and delivery situations
3. Discuss the methods to assess the accuracy of image registration and fusion
4. Discuss issues related to acceptance testing and quality assurance for image registration and fusion

TG-132 VORSCHLAG FÜR PRÜFMITTEL

Commissioning Datasets*

- Basic geometric phantoms (multi-modality)[1]
- Pelvis phantom (CT and MR)[1]
- Clinical 4D CT Lung[2] with simulated exhale[1]

*To be made publically available following the approval of TG 132 by AAPM

1. Courtesy of ImSim QA
2. Courtesy of DIR Lab, MD Anderson Cancer Center

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BEISPIEL EINER PLANUNG UND CBCT VERIFIKATION

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ÜBERTRAGUNG DES BESTRAHLUNGSPLANS (DIR/RIR) AUF DIE CBCT BILDER

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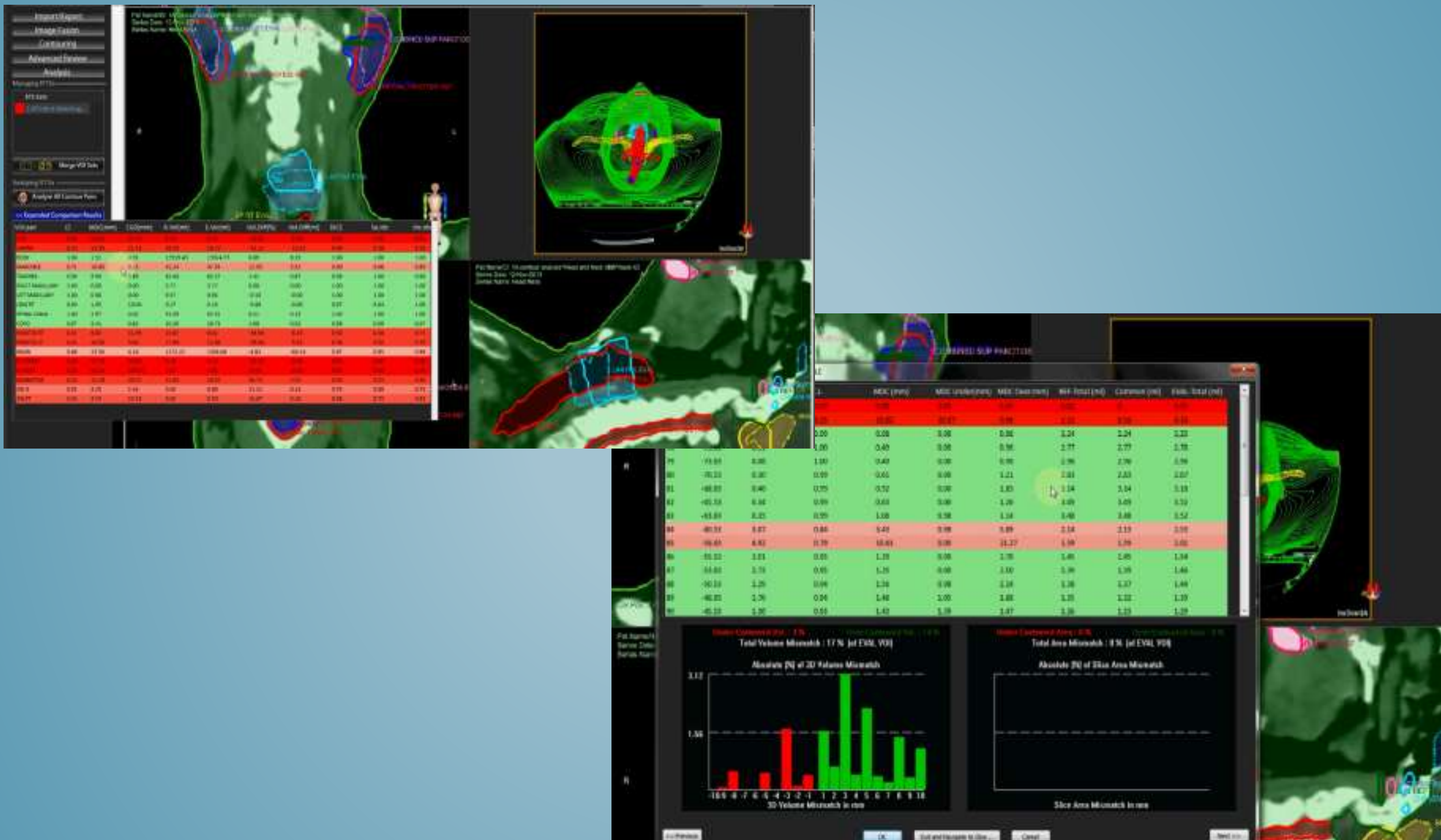
ANALYSE BEZÜGLICH DER NOTWENDIGKEIT EINER NEUPLANUNG



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VERÖFFENTLICHUNGEN

Comparison of Image Registration Packages for Use in Radiotherapy Planning

Eyre K, Thomas SJ
Medical Physics Department, Addenbrooke's Hospital, Cambridge, CB2 0QQ

FULL PAPER

The utility of atlas-assisted segmentation in the male pelvis is dependent on the interobserver agreement of the structures segmented

JOURNAL OF APPLIED CLINICAL MEDICAL PHYSICS, VOLUME 14, NUMBER 1, 2013

A framework for deformable image registration validation in radiotherapy clinical applications

Raj Varadhan,[1,4a] Grigorios Karangelis,[2] Karthik Krishnan,[3] Susanta Hui[4]
Minneapolis Radiation Oncology,[1] Minneapolis, MN, USA; Oncology Systems Limited,[2] Shrewsbury, Shropshire, UK; Kitware, Inc.,[3] Clifton Park, NY, USA; Department of Therapeutic Radiology,[4] University of Minnesota, Minneapolis, MN, USA
rvaradhan@mropa.com

Received 11 June, 2012; accepted 19 September, 2012

Quantitative validation of deformable image registration (DIR) algorithms is extremely difficult because of the complexity involved in constructing a deformable phantom that can duplicate various clinical scenarios. The purpose of this study is to describe a framework to test the accuracy of DIR based on computational modeling and evaluating using inverse consistency and other methods. Three clinically relevant organ deformations were created in prostate (distended rectum and rectal gas), head and neck (large neck flexion), and lung (inhale and exhale lung volumes with variable contrast enhancement) study sets. DIR was performed using both B-spline and diffeomorphic demons algorithms in the forward and inverse direction. A compositive accumulation of forward and inverse deformation vector fields was done to quantify the inverse consistency error (ICE). The anatomical correspondence of tumor and organs at risk was quantified by comparing the original RT structures with those obtained after DIR. Further, the physical characteristics of the deformation field, namely the Jacobian and harmonic energy, were computed to quantify the preservation of image topology and regularity of spatial transformation obtained in DIR. The ICE was comparable in prostate case but the B-spline algorithm had significantly better anatomical correspondence for rectum and prostate than diffeomorphic demons algorithm. The ICE was 6.5 mm for demons algorithm for head and neck case when compared to 0.7 mm for B-spline. Since ... between ... tids, and ... rmations ... morphic ... ariation ... s on any ... lgorithm ... ondence, ... facilitate ... therapy ... g DIR is

Validation of Deformable Dose Registration using B-spline and Optical-flow algorithm in Head and Neck cancer patients

Comparison of different QA methods for deformable image registration to the known errors for prostate and head and neck virtual phantoms

UT Health Science Center
UCSF

A virtual phantom library for the quantification of deformable image registration uncertainties in patients with cancers of the head and neck

Jason Pukala,[a] Sanford L. Meeks, and Robert J. Staton
Department of Radiation Oncology, MD Anderson Cancer Center Orlando, Orlando, Florida 32806
Frank J. Bova
Department of Neurosurgery, University of Florida, Gainesville, Florida 32611
Rafael R. Mañon and Katja M. Langen
Department of Radiation Oncology, MD Anderson Cancer Center Orlando, Orlando, Florida 32806

(Received 23 May 2013; revised 1 August 2013; accepted for publication 6 September 2013; published 2 October 2013)

Purpose: Deformable image registration (DIR) is being used increasingly in various clinical applications. However, the underlying uncertainties of DIR are not well-understood and a comprehensive methodology has not been developed for assessing a range of interfraction anatomic changes during head and neck cancer radiotherapy. This study describes the development of a library of clinically relevant virtual phantoms for the purpose of aiding clinicians in the QA of DIR software. These phantoms will also be available to the community for the independent study and comparison of other DIR algorithms and processes.

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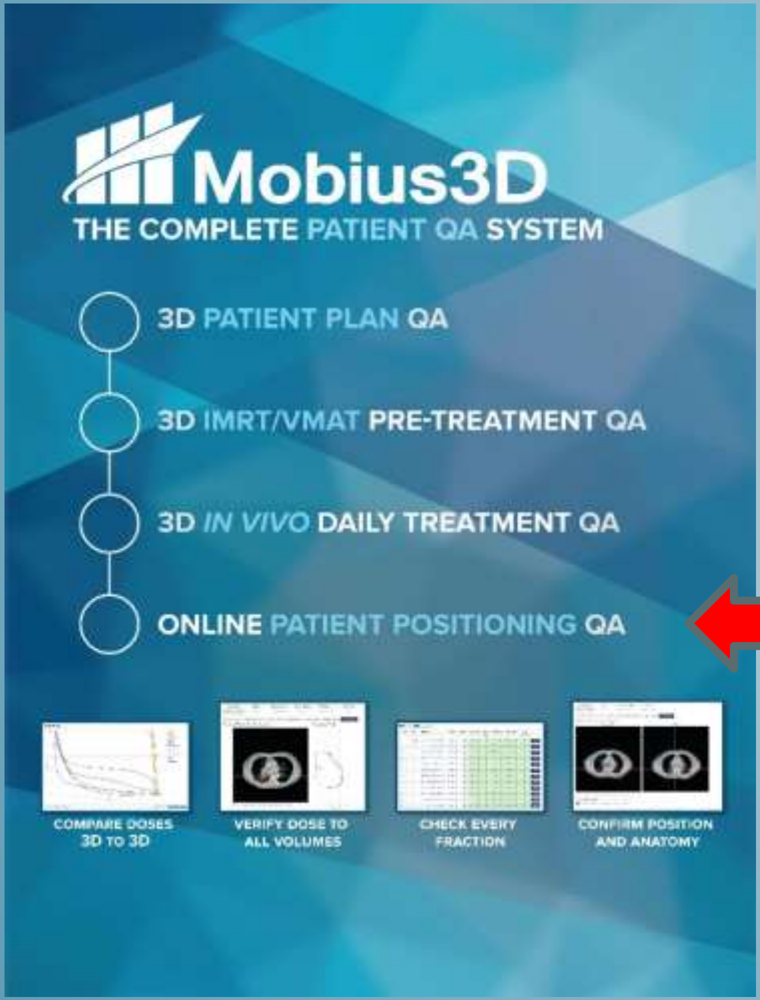
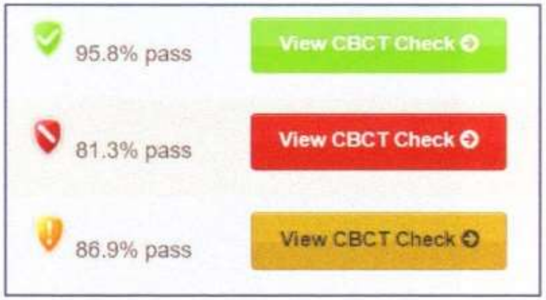
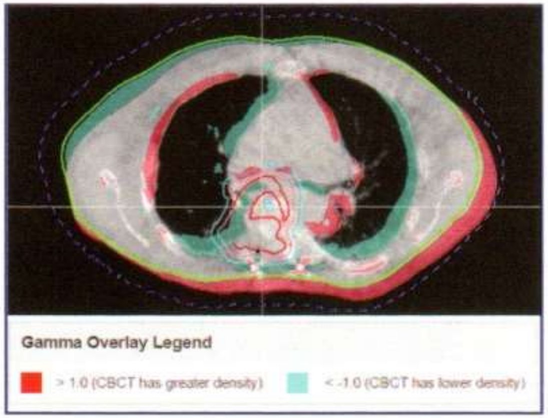
MOBIUS3D
DAS KOMPLETTE SYSTEM FÜR PATIENTEN QS



VON QUALITATIV → ZU QUANTITATIV FÜR DEFORMIERUNGEN UND POSITIONIERUNGEN



Quantitative values and color coding allow fast analysis of results



Density gamma overlay provides clear indication of positioning errors

EINE GAMMA DENSITY ANALYSE

The CBCT Module: Density gamma

- Same method as dose comparison, but now we are comparing (g/cc) per distance
- Default criteria: 0.3 g/cc / 3 mm
  - This value was chosen because it best distinguishes between bone, soft tissue, and air, which are the differences that will clearly show positioning errors and anatomy changes
- Three options for gamma region of interest:
  - "% Dose" + Margin
  - Isocenter + Margin
  - All Target ROIs - not recommended

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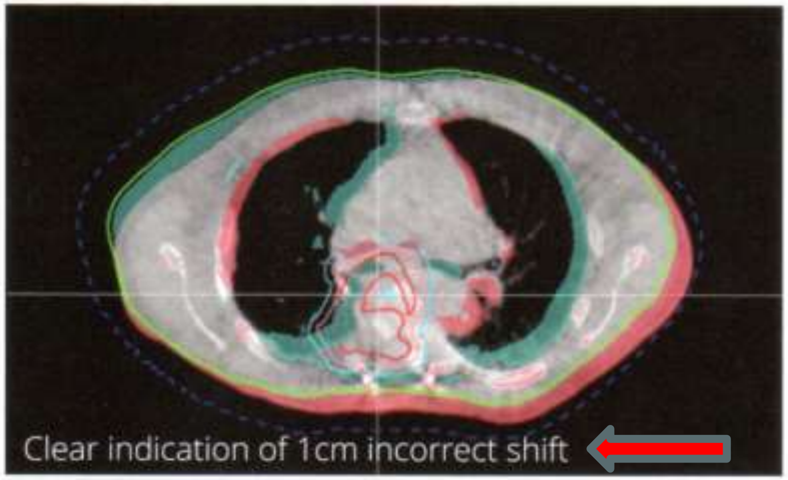
QUANTITATIVE PRE-TREATMENT POSITIONIERUNG

CBCT Analysis for Pre-treatment QA

Passing Rate	Criteria	Planning CT Voxels	CBCT Voxels
94.5%	0.3 g/cc / 3 mm	2 mm, 0.97 mm, 0.97 mm	2 mm, 0.97 mm, 0.97 mm

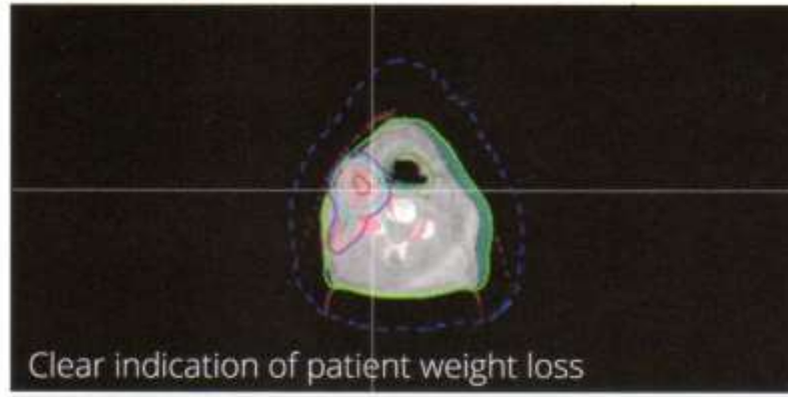


Passing Rate	Criteria	Planning CT Voxels	CBCT Voxels
76.9%	0.3 g/cc / 3 mm	2 mm, 0.97 mm, 0.97 mm	2 mm, 0.97 mm, 0.97 mm

QUANTITATIVE POST-TREATMENT ANALYSE DER ANATOMISCHEN VERÄNDERUNGEN

CBCT Analysis for Post-treatment QA

Passing Rate	Criteria	Planning CT Voxels	CBCT Voxels
91.5%	0.3 g/cc / 3 mm	2 mm, 1.14 mm, 1.14 mm	2 mm, 1.14 mm, 1.14 mm



Passing Rate	Criteria	Planning CT Voxels	CBCT Voxels
86.9%	0.3 g/cc / 3 mm	2 mm, 1.14 mm, 1.14 mm	2 mm, 1.14 mm, 1.14 mm

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MOBIUS3D CBCT SPEZIFIKATION

Mobius3D CBCT Module Specifications

Supported Machines	Varian and Elekta linear accelerators with cone-beam CT capabilities
Supported R&V Systems	Varian ARIA® and Elekta MOSAIQ®
Comparison Method	The CBCT and Planning CT volume comparison is completed utilizing automatic re-scaling of intensity values and user specified density (g/cc) / distance (mm) criteria
Views Available	Transverse Gamma, Coronal Gamma, Sagittal Gamma, and Transverse 3D Slice Viewer

MOBIUS MEDICAL SYSTEMS

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POSITIONSBESTIMMUNGEN

SYSTEME ZUR ERFASSUNG VON BEWEGUNGEN VON KÖRPERSTRUKTUREN

ECHTZEIT ELEKTROMAGNETISCHES TUMOR TRACKING

RayPilot das System zur Erfassung von:

- **Echtzeit Organbewegungen**

und

- **In Vivo Punktdosimetrie**

während der Bestrahlung

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RAYPILOT®

Das Echtzeit Tumortracking System
für jeden Beschleuniger

Das macht den Unterschied aus:

- 30 Hz Meßfrequenz
- Auch für Lagerungen aus Kohlenstoff-Faser, kein Verbleib von körperfremden Teilen im Patienten nach der Anwendung
- MRT Nachuntersuchungen möglich
- Unabhängig von Körpergewicht und Körpergröße
- Für SBRT, IMRT und VMAT Bestrahlungen

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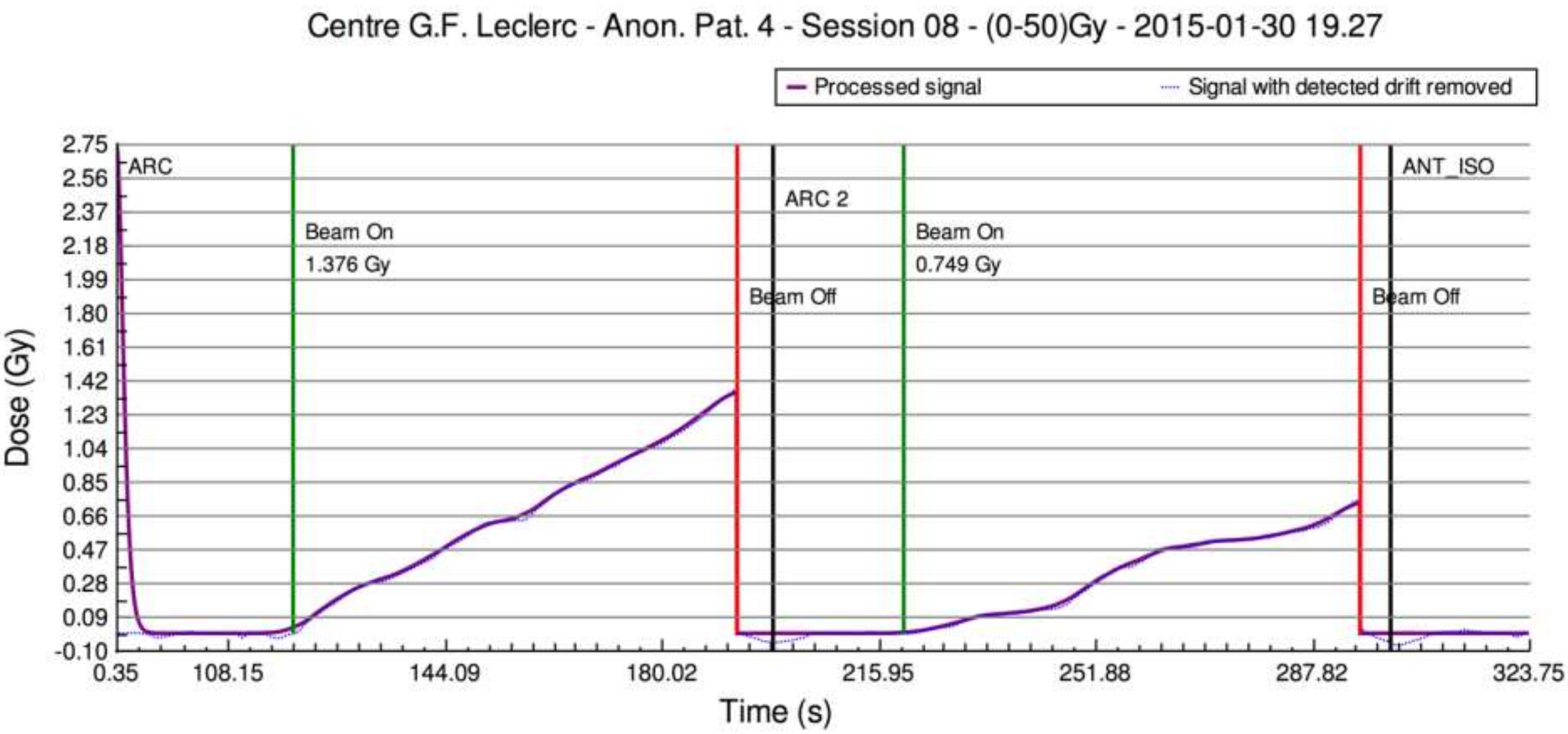
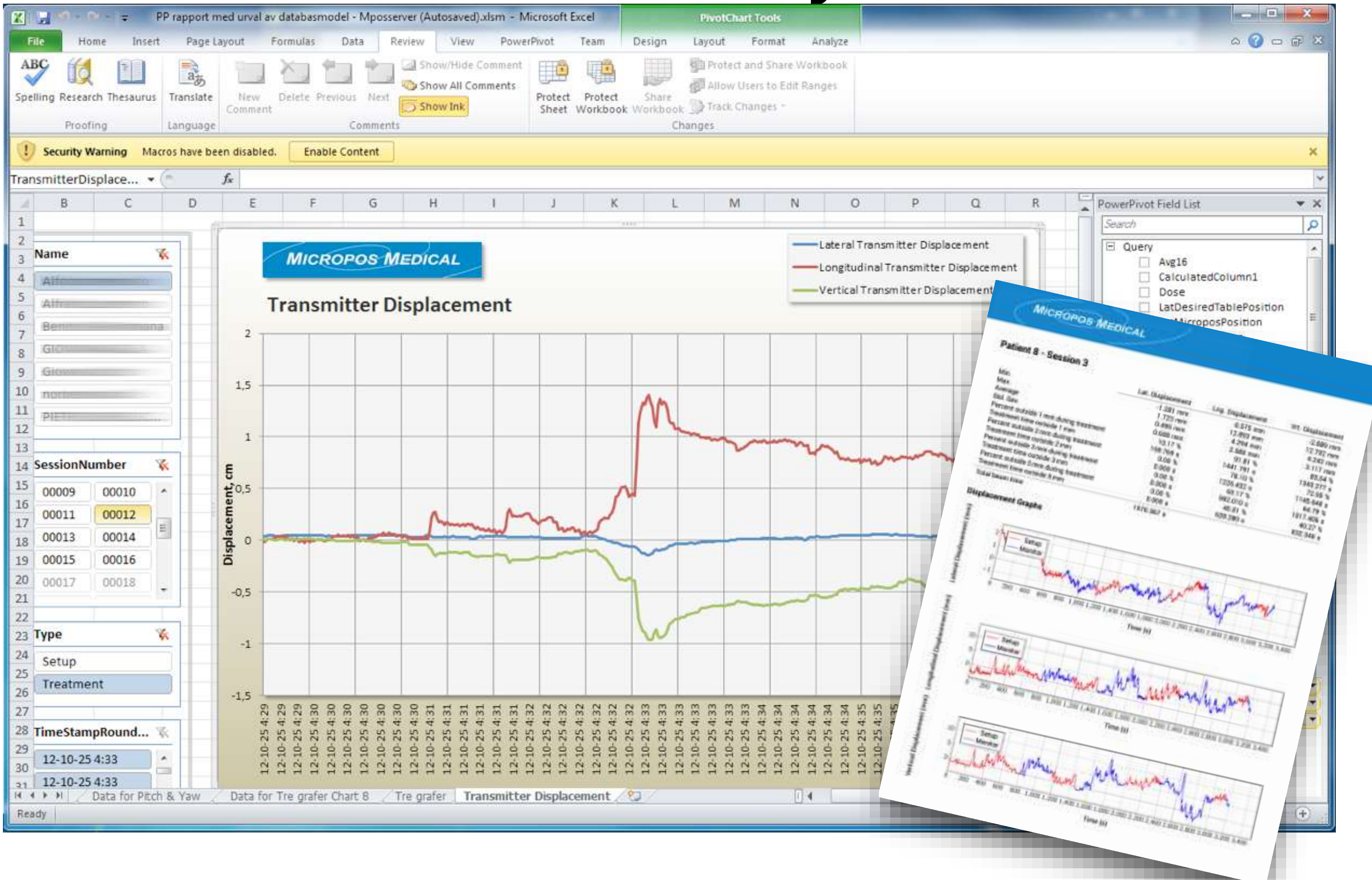
Centre Georges François Leclerc, Dijon

Example of in-situ dose data in prostate from one fraction (2 arcs)

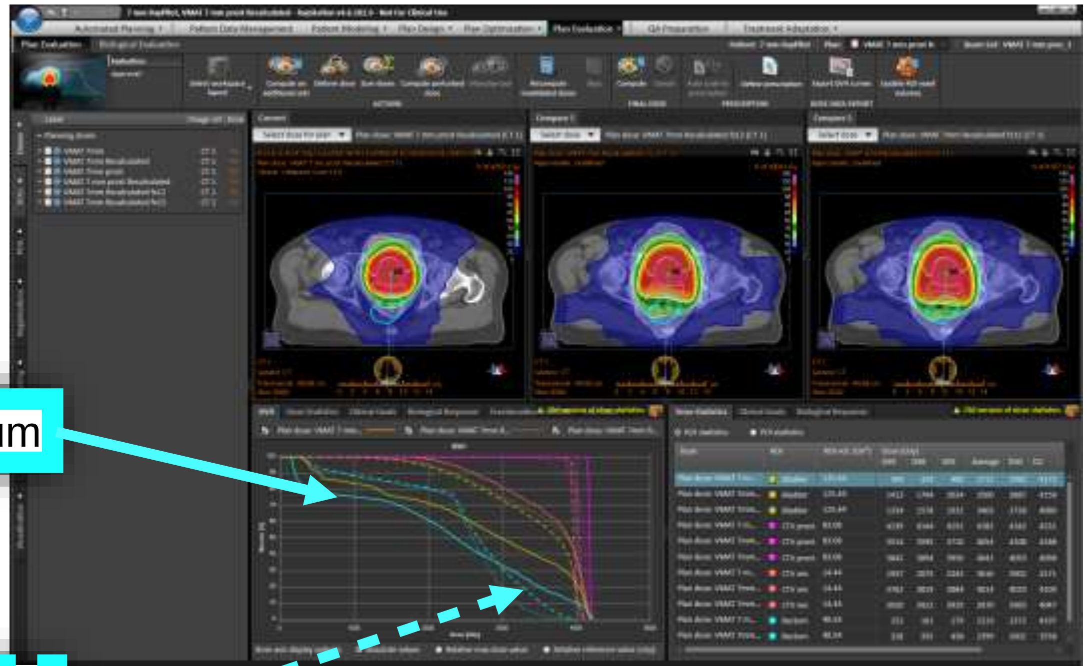


Work in progress

Offline analysis



Example of dose tracking performed by RayStation® from RayPilot® data. Compares the dose distribution from the plan with a recalculated dose distribution according to the motion detected.



Planned DVH Rectum

Recalulcated DVH Rectum

WORK IN PROGRESS

Prostate displacement monitored and recorded by RayPilot®. Dose tracking (deformableregistration, dose calculation and dose mapping) performed by RayStation® from RaySearch.

PHANTOME FÜR DOSIMETRISCHE MESSUNGEN

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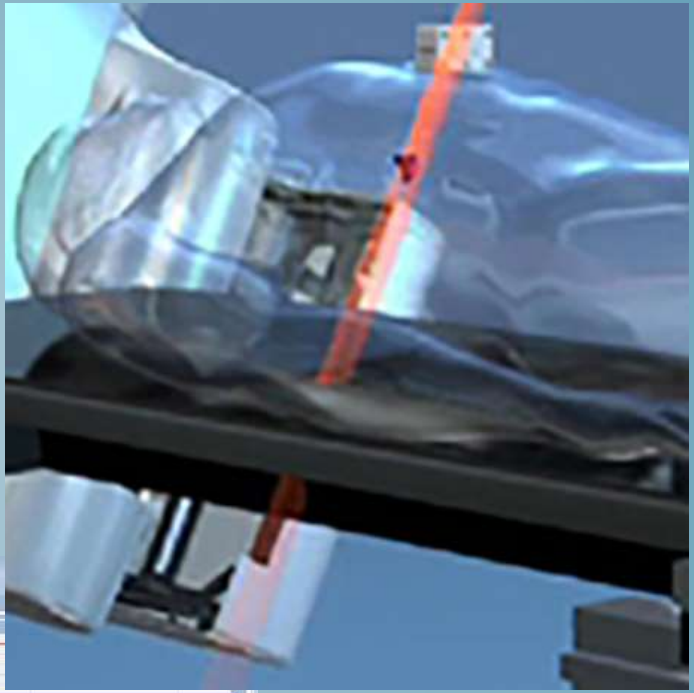
ATMUNGSABHÄNGIGE BEWEGUNG VON KÖRPERSTRUKTUREN



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DAS MODUS QA ATMUNGSSIMULATIONS PHANTOM
AUFBAUMÖGLICHKEITEN AUF EINEN BLICK
EINSÄTZE UND ZUSATZTEILE

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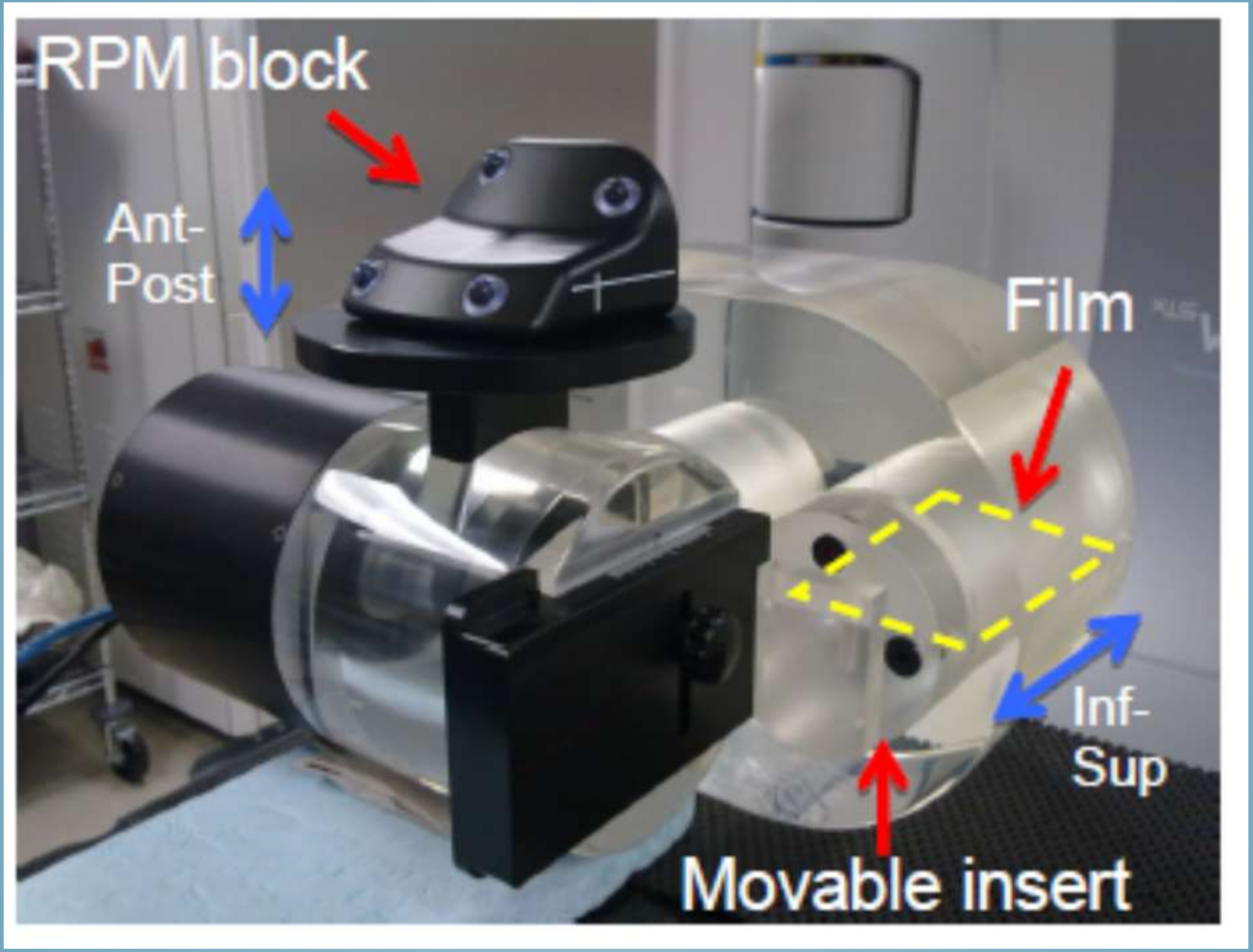
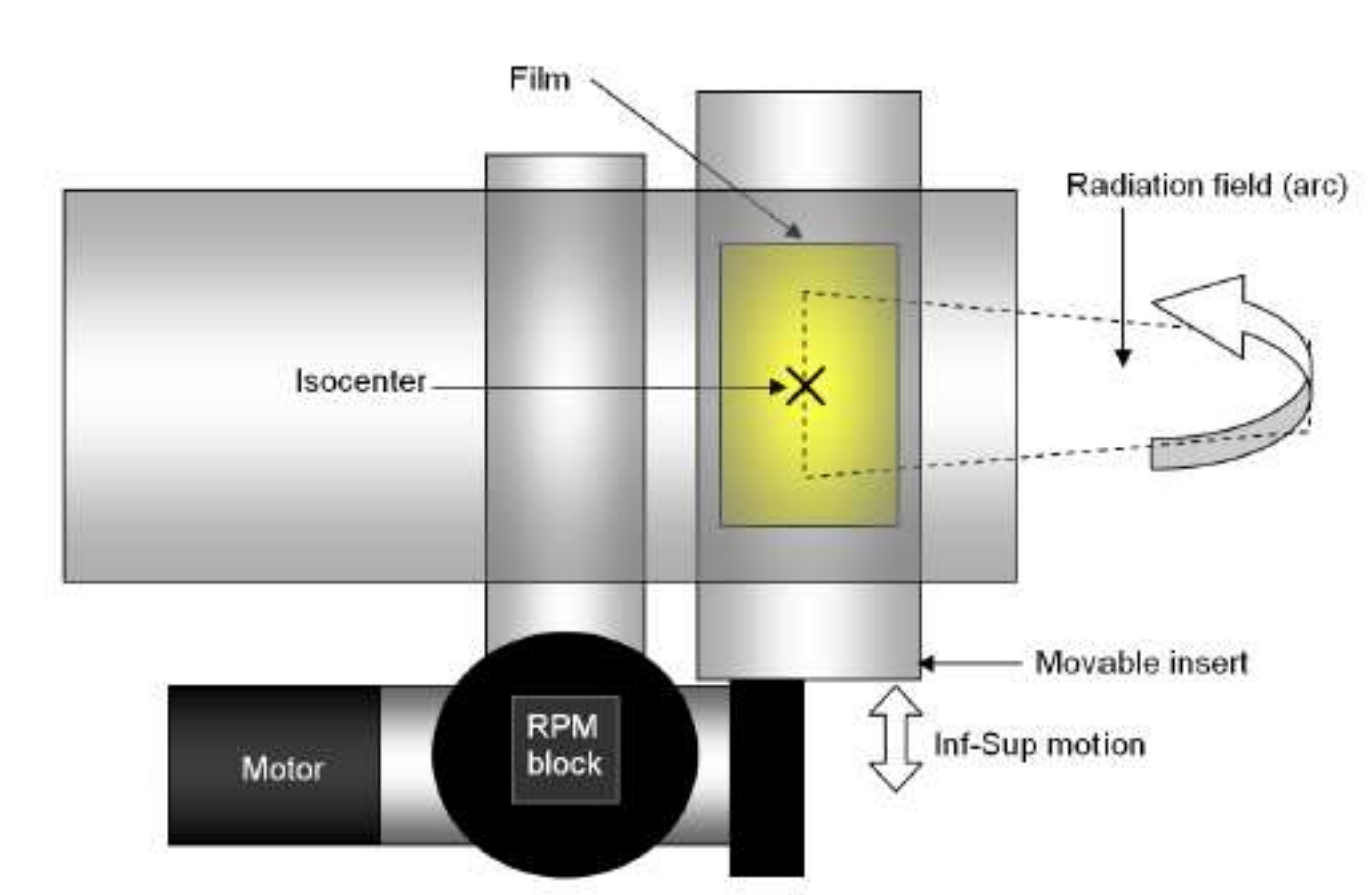
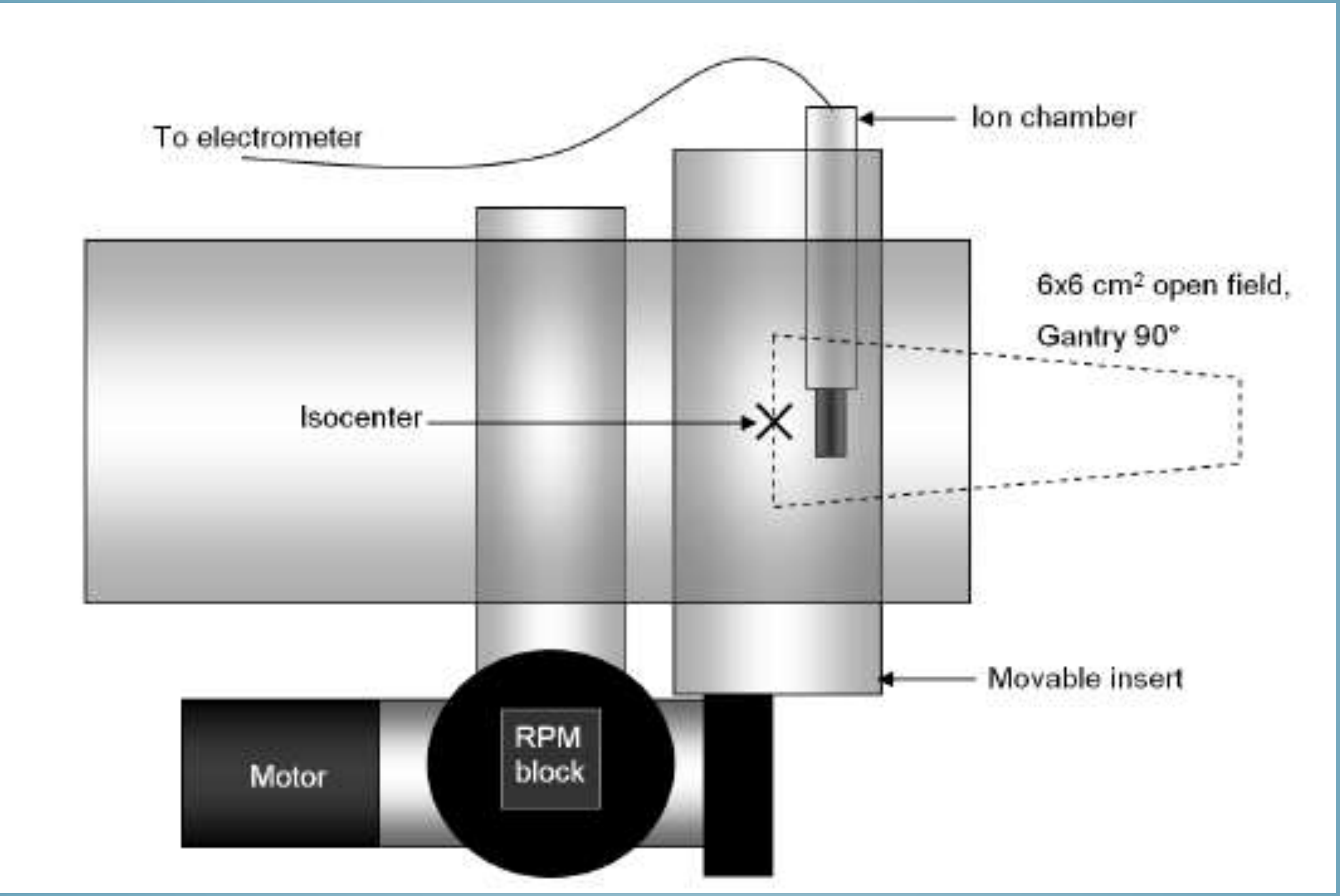
MODUS QA PHANTOM MIT VARIAN RPM SYSTEM



MODUS QA ATMUNGSSIMULATIONS PHANTOM SCHEMATISCHER AUFBAU MIT GAFCHROMIC FILM



ATMUNGSSIMULATIONS PHANTOM MIT MESSKAMMER EINSATZ



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MODUS QA BEWEGUNGS PLATTFORM MIT ATMUNGSKURVEN - STEUERUNG MIT 2D BEWEGUNG

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MODUS QA BEWEGUNGS PLATTFORM MIT ATMUNGSKURVEN - STEUERUNG MIT 3D BEWEGUNG

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MODUS QA PLATTFORM – SPEZIFIKATIONSPARAMETER

QUASAR™ Programmable Respiratory Motion Platform Specifications

- Moving Platform; 35 cm x 35 cm, carries up to 20 kg
- Overall dimensions; 51 cm x 35 cm x 15 cm high
- Mass; 3 kg excluding third party phantoms
- Chest wall platform: 13 cm diameter, carries up to 1 kg
- Power supply: Input, 100 – 240 V AC, 47 – 63 Hz, International power cords available
  Output, 24 V DC 2.1 A, 50 W. Approvals; CE, UL/CSA 60950-1

Key Features

- Accomodates phantoms weighing up to 20 kg on a 35 x 35 cm platform
- Generates lateral hysteresis motion for phase separation testing
- Simulates patient-specific respiratory and sinusoidal motion profiles
- Communicate with the phantom through local area network (LAN)
- Compatible with motion tracking systems from multiple vendors

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VIELEN DANK FÜR IHRE AUFMERKSAMKEIT !

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