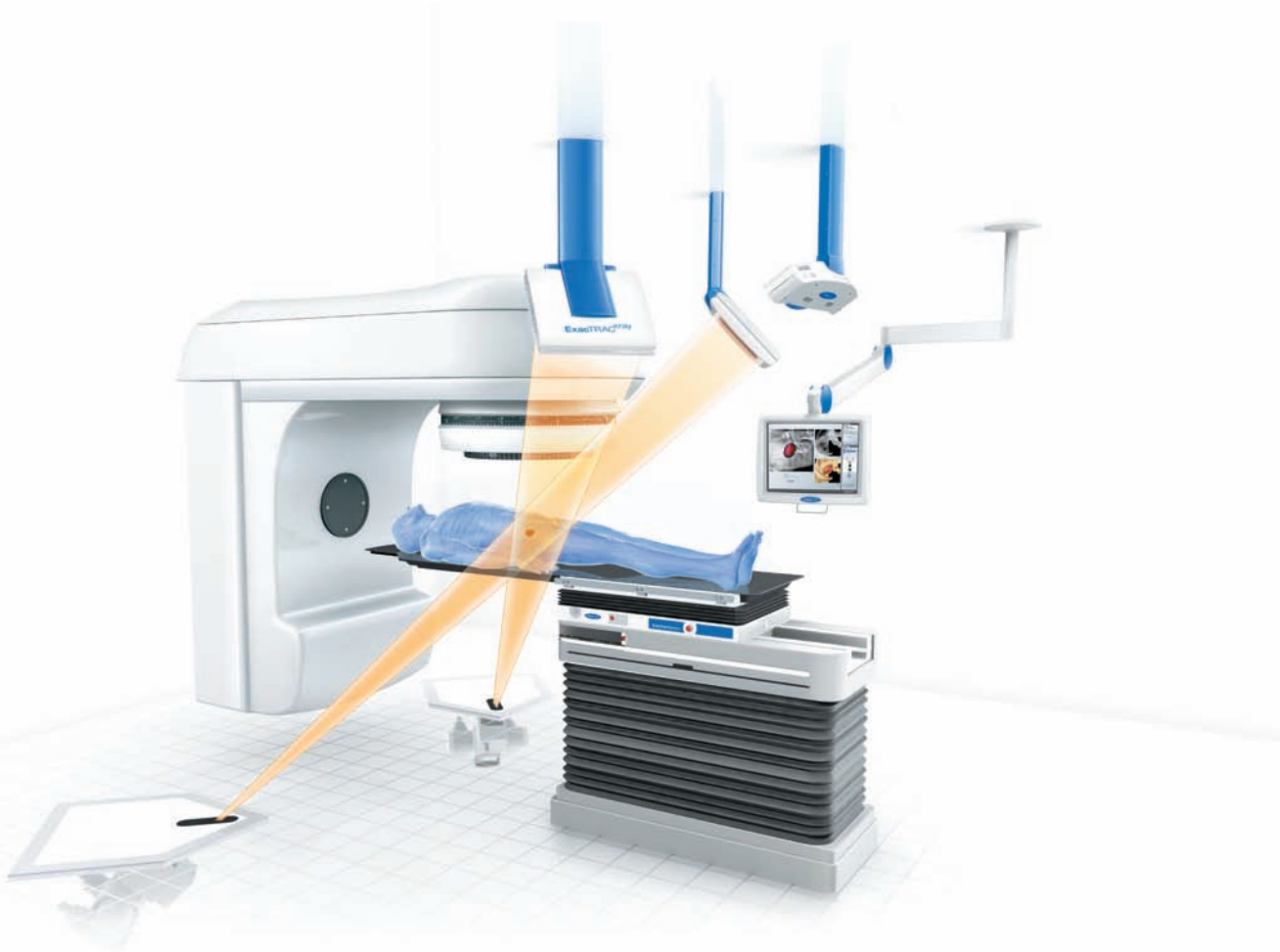


IGRT with ExacTrac®





ExacTrac® IGRT

ExacTrac® is a clinically proven, highly precise automated IGRT system that provides the confidence of daily millimeter targeting accuracy for unlimited treatment possibilities.

ExacTrac enables precise patient setup in a quick, automated two-minute process—high-resolution stereo x-ray imaging targets tumors and corrects patient positioning with sub-millimeter precision. The room-based design supports continuous tracking of patient movement, including IGRT verification throughout treatment.

ExacTrac offers a solution for the growing need to detect and compensate for patient and random or breathing-induced tumor movement during treatment fractions.



ExacTrac installed at CARTI, Little Rock, Arkansas, USA

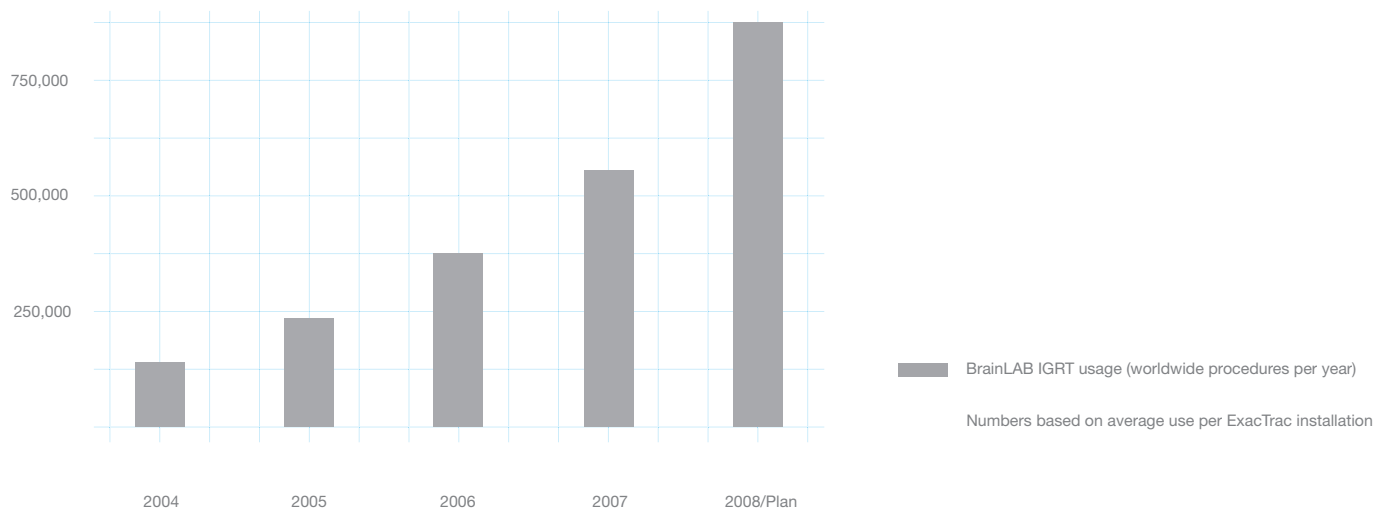
CLINICALLY PROVEN IGRT

ExacTrac® consists of two kV x-ray units recessed into the Linac room floor and two ceiling-mounted amorphous silicon flat panel detectors. The integrated optical infrared tracking system continuously monitors patient positioning throughout treatment.

- Clinically proven precise patient setup within 1-2 mm
- Two-minute patient setup
- Intuitive, consistent workflow for each procedure
- Versatile IGRT platform for all treatment sites
- Zero downtime installation option

CLINICAL CONFIDENCE

BRAINLAB IGRT: UTILIZATION GROWTH WORLDWIDE



CLINICAL CONFIDENCE

Each year, ExacTrac® is used in over 500,000 IGRT patient treatments. These patients benefit from more effective treatment outcomes due to the system's highly accurate tumor targeting.

Leading institutions worldwide have chosen ExacTrac as their IGRT solution for better treatment and care and rely on its precise IGRT patient setup and high, unrestricted throughput.

Central Arkansas Radiation Therapy Institute (CARTI), a radiation therapy center with seven facilities located throughout Arkansas, USA, has installed a total of eight ExacTrac systems over a three-year period, and uses the systems to setup and monitor patient positioning throughout treatment for many of their patients.

To determine the most applicable IGRT technology for their case mix, CARTI installed and compared leading IGRT solutions at their facilities. After clinical evaluations of factors including setup precision, workflow, integration, installation and training, CARTI concluded that ExacTrac best met their needs.

“The decision making process in selecting an IGRT solution for CARTI involved evaluation of multiple parameters. We based our decision to move forward with ExacTrac primarily on it's targeting accuracy in combination with IGRT workflow efficiency and ease of use. These characteristics allow us to treat all appropriate patients at each of our centers with IGRT precision.”

Larry Berkley, VP Medical Physics, Engineering, and I.S., CARTI

EFFICIENT WORKFLOW

Step 1: One-Minute Pre-Positioning



EFFICIENT WORKFLOW

ExacTrac® enables precise patient positioning within millimeter accuracy in a quick, automated two-minute process.

The standardized workflow ensures daily consistency in setup, verification and documentation for fast, safe treatment for each patient and fraction.

The entire x-ray acquisition and verification procedure can be conducted by a therapist from the console room, allowing flexibility in the physician's schedule.

- Fast, two-minute IGRT with no impact on patient throughput
- Standardized workflow for fast and easy implementation of IGRT and related SBRT tools
- Automatic image verification allows the therapist to independently perform the setup process

Step 1: Pre-Positioning

The patient is pre-positioned either automatically, using the ExacTrac remote couch interface*, or conventionally. ExacTrac provides millimeter precise setup automatically, eliminating time-consuming manual alignment of patient skin markers to room lasers. With ExacTrac, the therapist can position the patient in general proximity of the x-ray field of view, leave the room and start IGRT setup, saving critical time.

TWO – MINUTE IGRT SETUP

Step 2: One-Minute IGRT

Continuous Optical and IGRT Setup Monitoring



Step 2: Image-Guided Verification in 6D

Stereoscopic x-rays are acquired from the console. An immediate and automatic on-screen comparison of Digitally Reconstructed Radiographs (DRRs) and x-ray images is completed to verify patient setup.

ExacTrac® calculates any required patient shift and the remote couch* aligns the patient to the correct isocenter point. Optional ExacTrac Robotics automatically correct rotational setup errors.

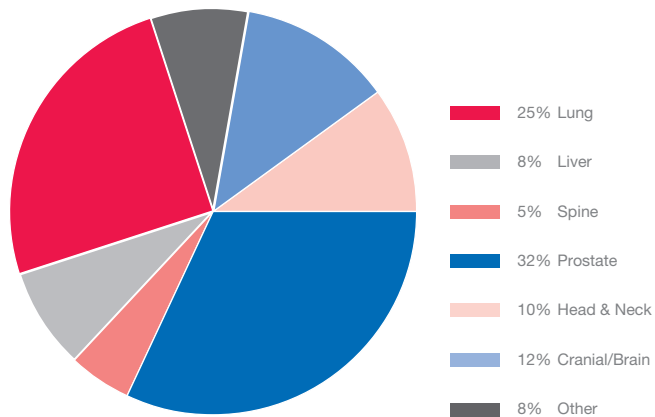
Continuous Position Monitoring and Tumor Motion Management

Integrated optical infrared patient tracking monitors the patient in real-time, ensuring IGRT accuracy throughout treatment.

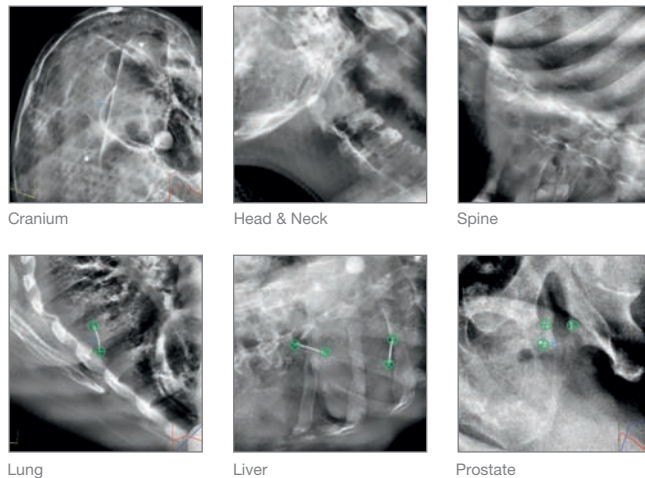
ExacTrac Snap Verification can acquire additional IGRT x-ray images at any time during treatment to detect intra-fraction shifts and indicate whether a setup correction shift is required.

*Remote couch movement available for Varian couches

UNLIMITED TREATMENT POSSIBILITIES



Average case mix for ExacTrac users as of 2007



IGRT VERSATILITY

ExacTrac® transforms your Linac into a versatile IGRT system with the power to treat more indications more effectively¹.

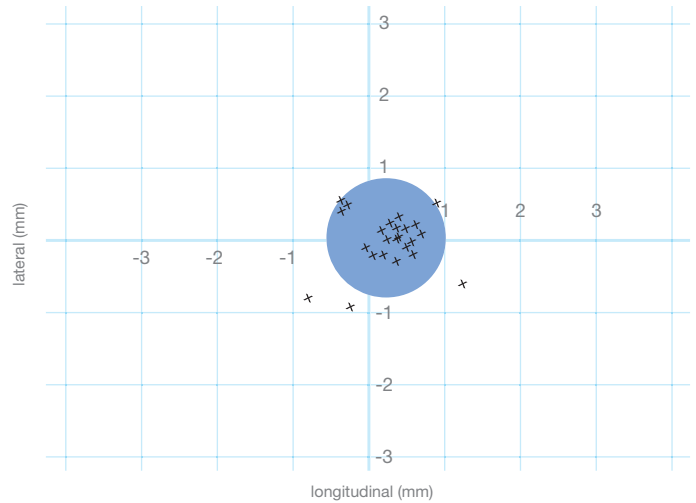
“We use ExacTrac to treat lung, GYN, H&N and prostate cancer. It has wide indications for its daily use. Due to the flexibility you can use it for bony landmarks and with fiducials.”

Ann Maners M.D., Central Arkansas Radiation Therapy Institute, Little Rock, Arkansas

“ExacTrac is very versatile in delivering SBRT to various anatomical sites².

Bin Teh, M.D., The Methodist Hospital, Houston, Texas

MILLIMETER IGRT PRECISION



Published millimeter setup accuracy of ExacTrac⁴

MILLIMETER PRECISION

ExacTrac[®] consistently provides millimeter-accurate target volume setup through imaging of internal structures or implanted markers¹. The high level of accuracy results from an advanced BrainLAB 6D image registration algorithm. Optional implanted fiducials further ensure superior IGRT setup accuracy compared to use of soft tissue data for patient setup³.

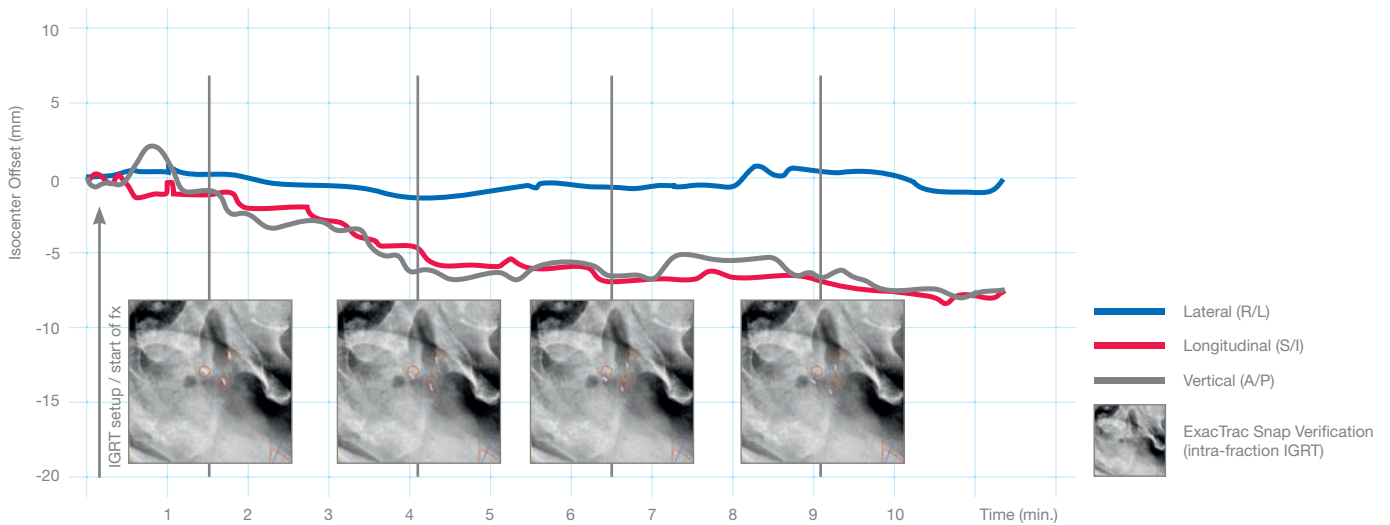
¹R. Wurm et al; Novalis[®] non-invasive frameless Image-Guided Radiosurgery: Initial Experience; Neurosurgery, 2008, Vol. 62, No. 6 (Suppl).

²Bin S. Teh et al.; Versatility of the Novalis[®] System to Deliver Image-Guided Stereotactic Body Radiation Therapy (SBRT) for Various Anatomical Sites; Technology in Cancer Research and Treatment, 2007, Vol. 6, No. 4.

³M. Langen et al; Initial Experience with Mv Ct Guidance for Daily Prostate Alignments; IJROBP, Vol. 62, 2005, No. 5, pp. 1517-1524.

⁴D. Verilen et al; AQ of a system for improved target localization and patient setup; RT Onc, 2003, Vol. 67, pp. 129-141.

TUMOR MOTION MANAGEMENT



Graph represents possible drift of prostate from isocenter in 3D over a 10 min. treatment fraction*. Motion occurs randomly and can change daily. Snap Verification images can be taken prior to each new treatment field.

IGRT FOR DETECTING ORGAN AND PATIENT MOTION

ExacTrac® Snap Verification detects and compensates for random patient and internal tumor movement throughout treatment. For example, up to 15 mm intra-fractional prostate movements are documented in clinical publications^{1,2}, and movements can exceed planned PTV safety margins. Clinical studies have also demonstrated that intra-fraction motion of the prostate gland occurs randomly, and may be as significant as inter-fraction motion¹, thereby impacting localization accuracy².

Snap Verification enables intra-fraction IGRT verification flexibility throughout treatment, including detecting mechanical inaccuracies from couch rotation, enabling safe delivery of advanced SBRT protocols and frameless radiosurgery treatments. For gated treatments, respiratory correlated image guidance is needed to account for PTV motion baseline shifts³. To ensure precise gating throughout treatment fractions, Snap Verification x-rays can be taken automatically and synchronized with the patient's breathing.



ExacTrac Snap Verification: Instant patient position monitoring and automatic intra-fraction x-ray image verification. Image courtesy of M. D. Anderson Cancer Center—Orlando, USA.



ExacTrac room-based design supports IGRT verification throughout treatment

SNAP VERIFICATION

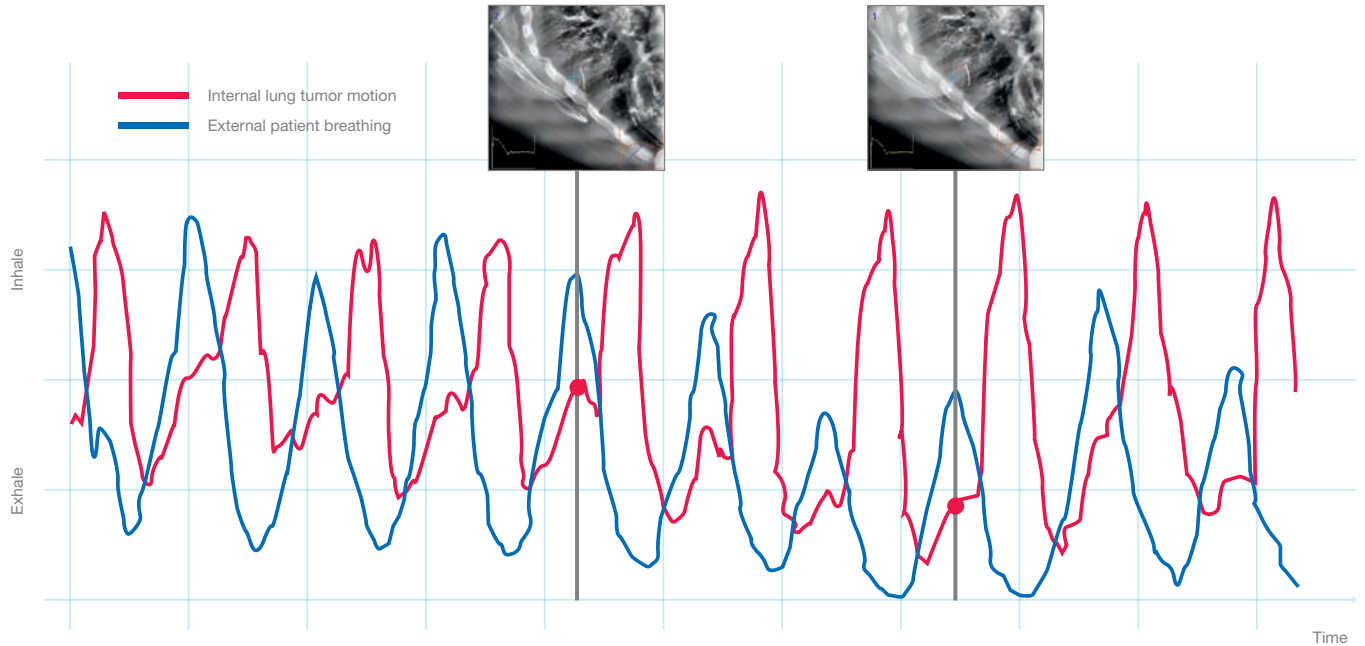
ExacTrac® Snap Verification software uses x-ray images acquired during treatment delivery or between fields to instantly detect and visualize internal tumor displacement. A threshold-based margin analysis algorithm indicates whether patient setup correction is recommended or not. ExacTrac automatic couch control can then be used to realign the patient remotely.

The room-based design of ExacTrac allows Snap Verification imaging to be performed instantly and at any time during treatment without moving any detectors or imaging units into position. Verification is also supported whether the treatment beam is on or off and for any gantry and couch position, further improving the overall accuracy of IGRT.

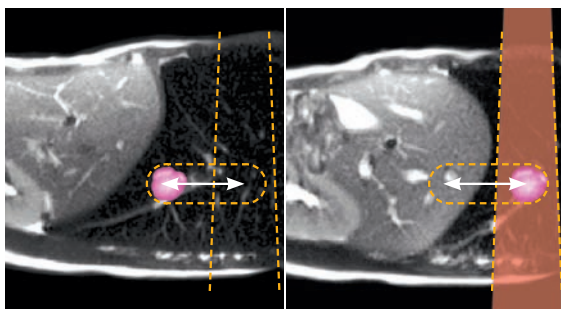
- Accurate targeting from start to finish of each fraction
- Software-integrated instant imaging and verification
- Immediate detection and visualization of intra-fraction tumor motion

¹Kupelian et al; Multi-institutional clinical experience...monitoring of the prostate gland during external radiotherapy; IJROBP, 2007, Vol. 67, pp. 1088-1098.
²K. Langen et al; Observations on Real-Time Prostate Gland Motion...; IJROP, 2008, pp. 1084-1090.
³S. Korreman et al; Respiratory gated beam delivery cannot facilitate margin reduction, unless combined with respiratory correlated image guidance; Radiotherapy and Oncology, 2008. Vol. 86, pp. 61-68.
⁴Intrafraction movement graph production is not a feature of ExacTrac

RESPIRATION MOTION MANAGEMENT



Possible drift of breathing pattern of a lung patient during gated treatment. Such baseline shifts and other intra-fraction changes need to be detected and corrected during gated treatment¹.

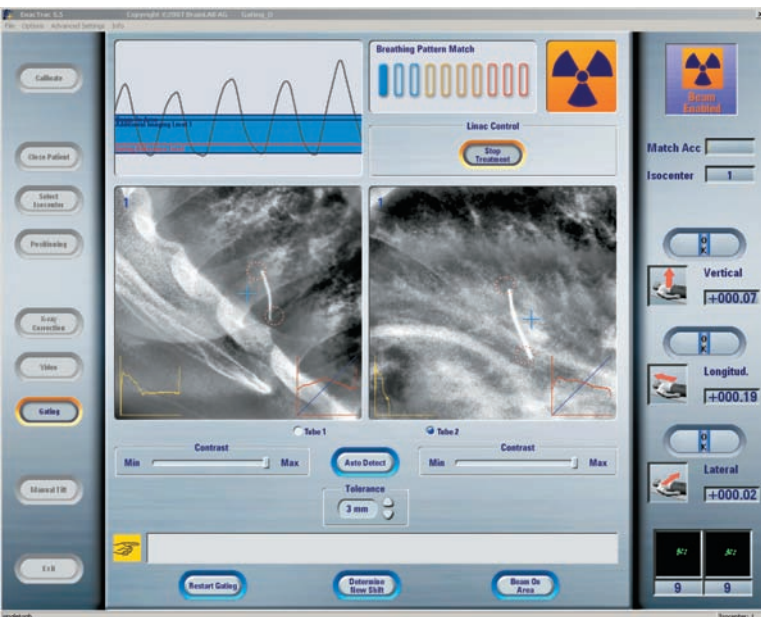


Left: Tumor moves out of treatment field due to respiration movement; ExacTrac suspends treatment beam. Right: Tumor moves into the treatment field; ExacTrac activates treatment dose. Images courtesy of R. Wurm, M.D., Frankfurt/O., Germany.

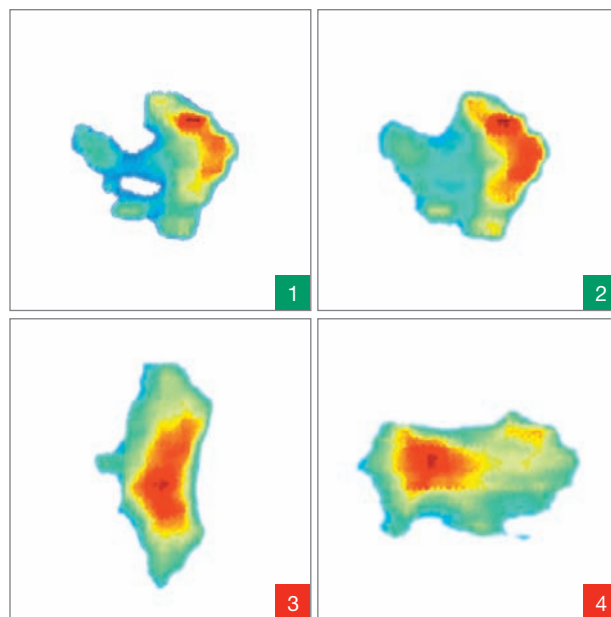
CLINICAL CHALLENGE: LUNG AND LIVER TUMORS

Respiration-induced tumor motion before and during treatment often prevents targeted, escalated dose delivery. Additionally, tumor motion requires large margins to ensure sufficient tumor coverage, which can adversely affect normal tissue toxicity. Beam gating improves target accuracy by addressing target motion.

PTV margins can only be reduced if respiratory baseline shifts and variations in a patient's external breathing patterns and internal tumor motion correlation are accounted for using image-guidance¹. For consistent, precise and safe gated treatment delivery, daily imaging of internal tumor position is essential before and during gated treatment.



ExacTrac Adaptive Gating acquires intra-fraction verification images synchronized with the patient's breathing pattern. Image courtesy of P. Kupelian, M. D. Anderson—Orlando, USA.



Effectiveness of ExacTrac Adaptive Gating: (1) Fluence map delivered without motion; (2) Fluence map with motion and in gated mode; (3) Fluence map without gating and motion orthogonal; and (4) parallel to leaf direction².

ADAPTIVE GATING

ExacTrac® addresses respiration induced tumor motion by uniquely combining continuous optical infrared patient tracking with x-ray IGRT verification of the internal PTV position via surrogates throughout the gated treatment. This gives confidence that daily respiration pattern changes and intra-fraction variation (e.g. breathing baseline shifts) are addressed.

- Millimeter accurate treatment setup before gated delivery
- Continuous real-time tracking of patient breathing patterns
- Gating of the Linac beam controlled by ExacTrac*
- X-ray variation of internal tumor motion during delivery
- Comprehensive QA

Inter- and intra-fractional patient setup displacements, as corrected by the gated setup and not detectable by a conventional setup, were up to 30 mm. Verification imaging to determine target location during treatment showed an average marker position deviation from the expected position of up to 4 mm on real patients.³

R. Wurm, M.D., Frankfurt/O., Germany

¹S. Korreman et al; Respiratory gated beam delivery cannot facilitate margin reduction, unless combined with respiratory correlated image guidance; Radiotherapy and Oncology, 2008, Vol. 86, pp. 61-68.

²Verellen D, Tournel K, Van de Steene J, Linthout N, Wauters T, Vinh-Hung V, Storme G. Breathing-synchronized irradiation using stereoscopic kv-imaging to limit influence of interplay between leaf motion and organ motion in 3D-CRT and IMRT: Dosimetric verification and first clinical experience; IJROBP, 2006, 66 (Suppl), pp. 108-119.

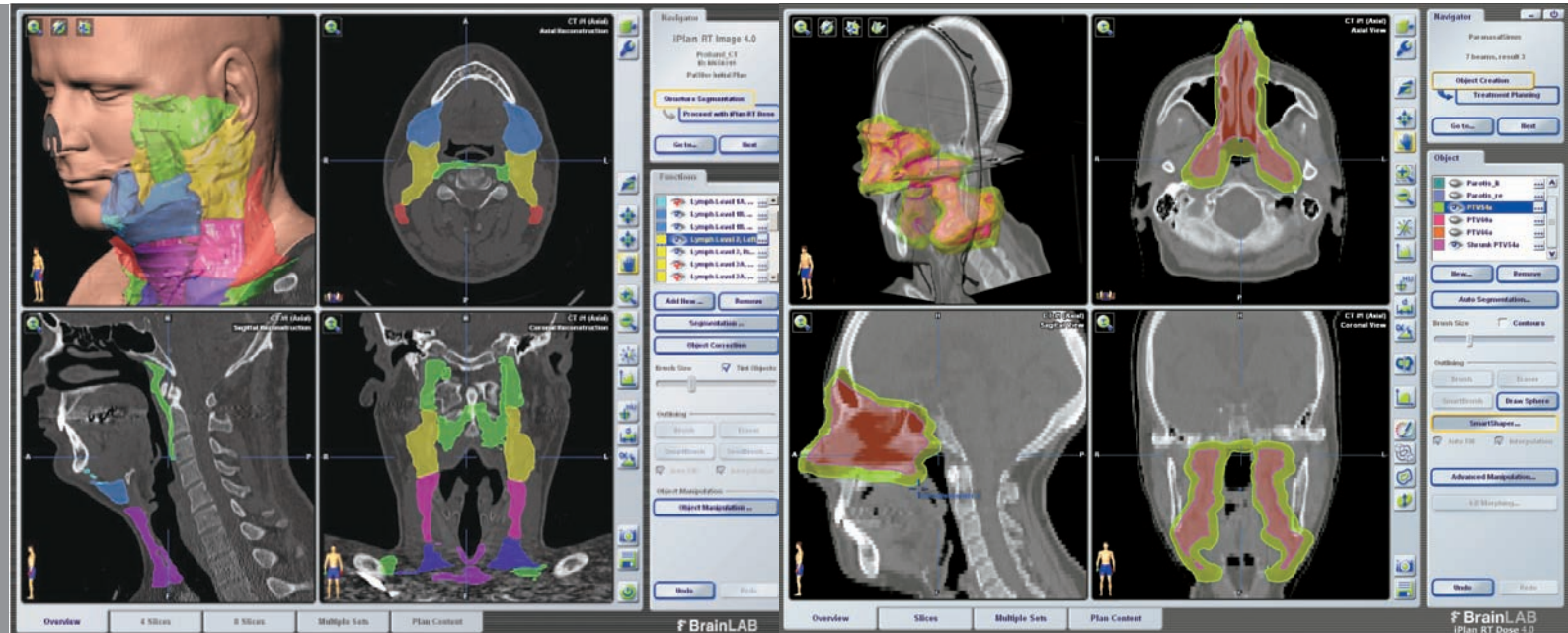
³Wurm R et.al: Image guided respiratory gated hypofractionated Stereotactic Body Radiation Therapy for liver and lung tumors: Initial experience. Acta Oncology, 2006, Vol. 45, pp. 881-889.

*BrainLAB Adaptive Gating received FDA clearance, availability pending release of 3rd party Linac interface

TUMOR SHRINKAGE MANAGEMENT

Step 1: iPlan Automatic Organ Segmentation

Step 2: iPlan Intuitive PTV Adaptation



ADDRESSING CHANGES IN TUMOR SHAPE

Advanced radiotherapy protocols that utilize IMRT and IGRT increase the need for periodic plan adaptation. If treatment plans are not periodically adapted, severe tumor shrinkage during the course of H&N treatments can have a serious dosimetric impact¹.

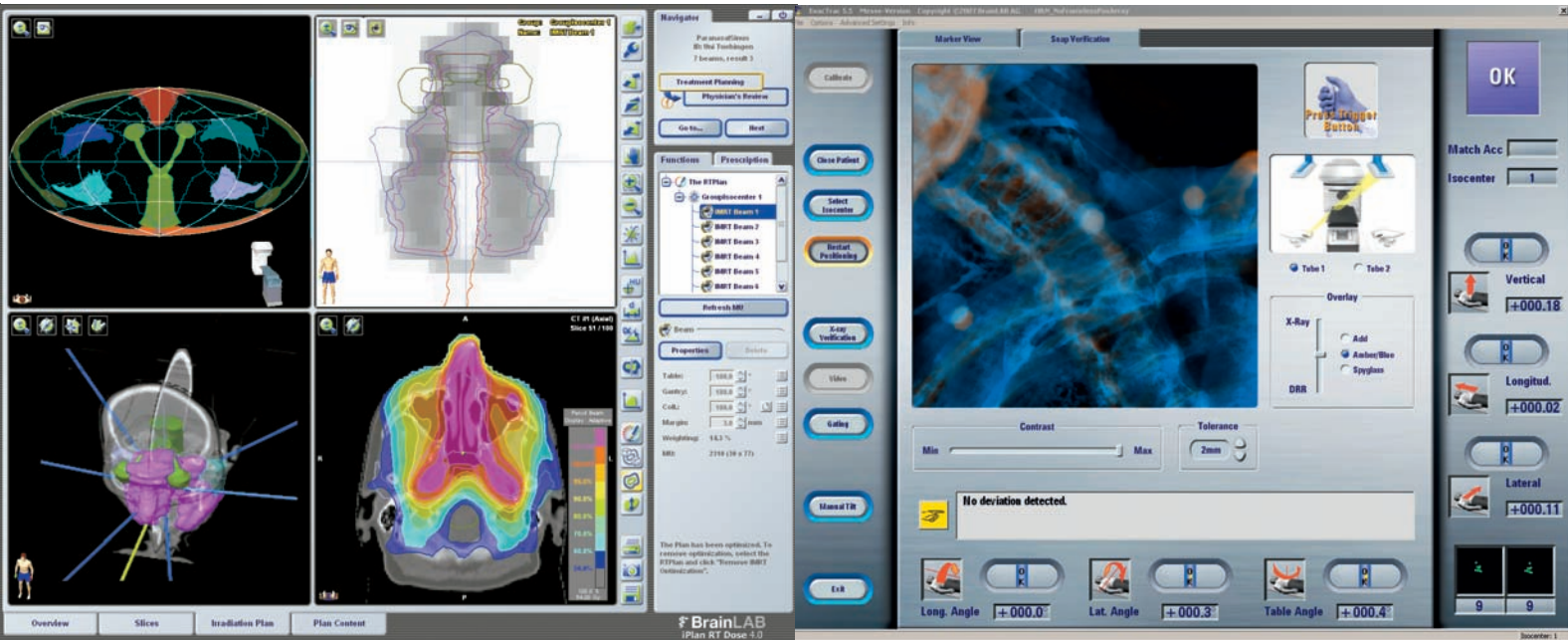


Image developed for DGMP, German Association of Medical Physics Challenge Case

ADAPTIVE RT

ExacTrac® together with BrainLAB iPlan® RT planning software addresses both target motion and tumor shrinkage during the course of a fractionated treatment.

iPlan RT makes periodic plan adaptations clinically and financially feasible. iPlan RT automatically facilitates efficient, intuitive plan updates based on periodic CT scans prompted by ExacTrac.

- Automatic Organ at Risk definition with iPlan RT Atlas Segmentation
- Fast PTV adaptation with iPlan RT Smartbrush® 3D object optimization
- iPlan Dose template plan update or DICOM RT export of adapted objects to dose engine
- Delivery of adapted plan with IGRT precision using ExacTrac

¹L. Dong et.al: Quantification Of Volumetric And Geometric Changes Occurring During Fractionated Radiotherapy For Head And Neck Cancer; IJROBP, 2004, Vol. 59, No. 4, pp. 960-970.

EXPANDING IGRT APPLICATIONS



ROBOTICS 6D PATIENT SETUP

The ExacTrac® remote couch provides the basis for fast, automatic patient setup and the ExacTrac Robotics* couch module automatically corrects rotational setup errors, offering further setup efficiency. ExacTrac Robotics also enables patient setup accuracy for stereotactic and IMRT cases, where tumors are in close proximity to critical structures.

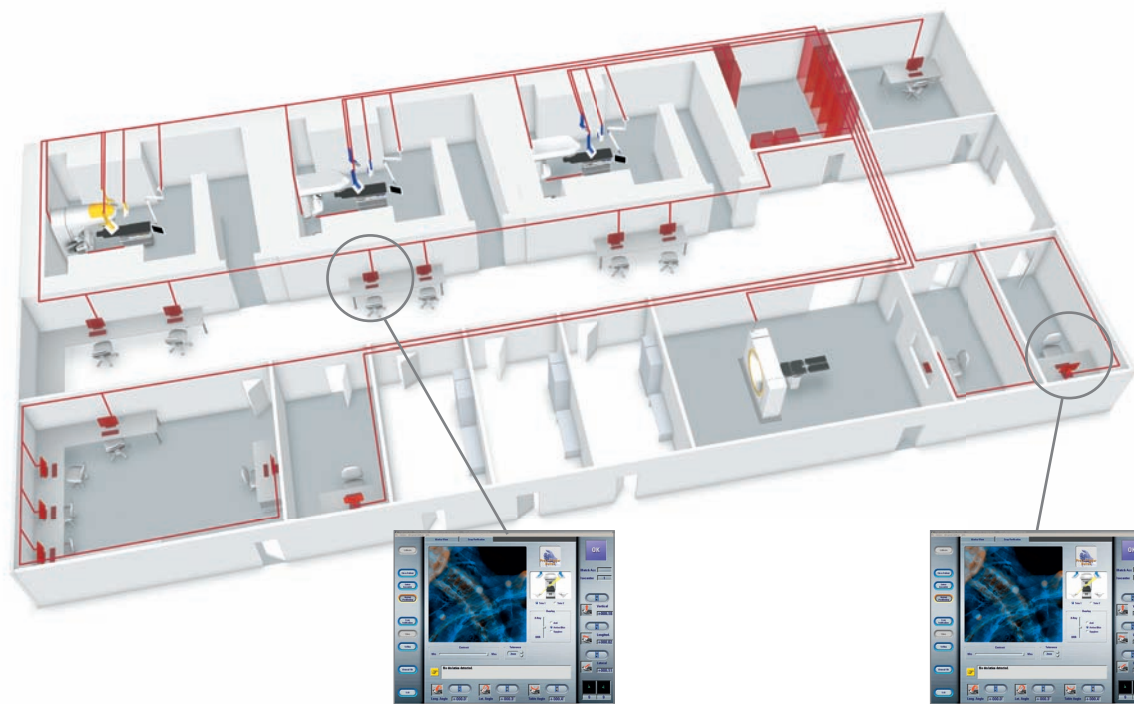
- Improved setup accuracy compared to x, y, z corrections alone¹
- Ideal for head & neck (H&N), spine, prostate and other SBRT/IMRT cases
- Improved setup speed for optimal patient throughput
- Superior image quality with carbon fiber Imaging Couch Top

FRAMELESS RADIOSURGERY

ExacTrac Frameless Radiosurgery, in combination with ExacTrac Robotics, offers highly accurate delivery of single fraction treatment without a conventional, invasive headring². A patient-friendly head-to-shoulder mask facilitates a streamlined workflow, overcoming the restrictions of frame-based radiosurgery and improving scheduling flexibility for imaging, planning and treatment.

- Single fraction radiosurgery and SRT for cranial and H&N cases supported with iPlan® stereotactic planning
- Stereotactic millimeter precision with patient's skull serving as localization geometry
- Stereotactic immobilization with three-piece, non-invasive mask

REMOTE ACCESS AND APPROVAL



The therapist oversees the physician's remote approval at the Linac console

Physicians can review and approve the IGRT setup from their office

IGRT WORKFLOW OPTIMIZATION

When performing IGRT, healthcare professionals are faced with clinical and legal challenges that may require direct involvement during treatment setup. ExacTrac® Live Access provides quick and simple connectivity to the IGRT workstation, allowing physicians to review and approve IGRT patient setup from their office or any connected network computer**. Physicians can now be involved throughout treatment without having to remain at the Linac console, increasing workflow efficiency and flexibility.

Additionally, all IGRT patient data including verification images, shift parameters and approval data, can be sent directly to the Record and Verify System (R&V)***.

With the ExacTrac Preparation and Review Workstation physicians can input patient data, develop setup plans and review IGRT reports outside the Linac control room without interfering with the patient treatment schedule.

- Remote access to IGRT console from any hospital network computer
- Physicians can approve IGRT from anywhere at anytime
- IGRT data report push to R&V systems
- Patient IGRT preparation without treatment flow interruption

¹G. Soete et. al.; Setup accuracy of stereoscopic x-ray positioning with automated correction for rotational errors...; RT Onc., 2006, Vol. 80, pp. 371-373.

²R. Wurm et al; Novalis® non-invasive frameless Image-Guided Radiosurgery: Initial Experience; Neurosurgery, 2008, Vol. 62, No. 6 (Suppl).

*Automatic couch motion available for Varian couches; Robotics available for Varian EXACT

**Requires existing LAN hospital network of min 100 MB, please consult BrainLAB for detailed specifications

***Ask your BrainLAB representative for a list of supported R&V systems

IGRT YOUR LINAC



ZERO DOWNTIME

BrainLAB offers a zero downtime installation option for ExacTrac® allowing facilities to upgrade their Linac while keeping their daily clinical routine and workflow on track.

The installation, testing and acceptance work is generally performed outside of the patient treatment schedule* during evening hours and on weekends, ensuring uninterrupted patient throughput and seamless integration of IGRT into your daily clinical workflow.

“The construction, installation and implementation of ExacTrac was a positive experience. We didn’t experience any downtime of our linear accelerators and we were up and running quicker than we’d expected. The on-site Application Training provided by BrainLAB was efficient and the required knowledge was transferred quickly to hospital staff.”

Scott Warwick, Cancer Service Line Leader, St. Mary’s Medical Center, Tennessee

*Installation times may vary depending on site and any special requirements

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