# CyberKnife®

## ACCURAY®


versatile simple VSI™ intelligent

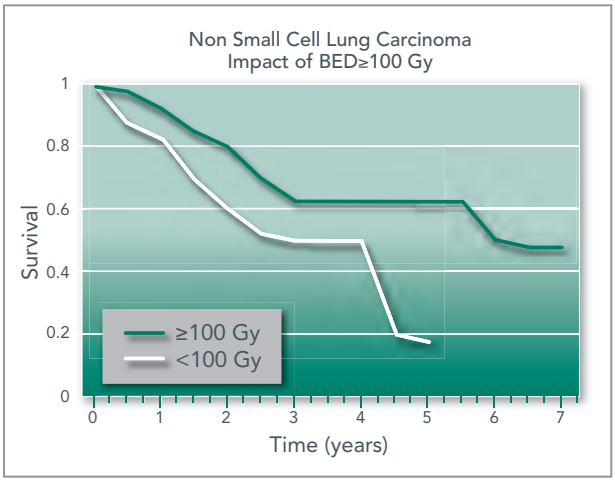
*With the ability to offer a full range of treatment options, from radiosurgery to high precision radiation therapy, the **versatile** CyberKnife® VSI™ System provides the flexibility to optimize treatments for the unique needs of each patient*

*A comprehensive set of tools to manage every aspect of patient treatment, ready integration into existing institution infrastructure and a logical workflow make the use of the CyberKnife VSI System **simple** and convenient in daily clinical practice*

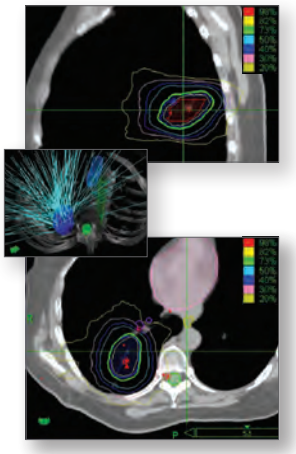

*Using **intelligent** capabilities to not only enable expert-level treatments with an intuitive planning process, but also to adapt treatment delivery to the distinct characteristics of each patient with continual image guidance, the CyberKnife VSI System instills confidence that the plan created is the plan delivered*

## Respiratory Motion Management

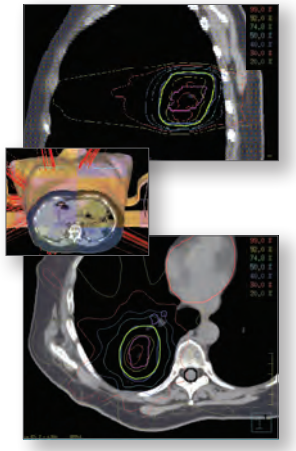
Managing respiratory motion presents one of the most significant challenges in radiation treatment delivery. While published evidence demonstrates a direct relationship between survival and efficacy with dose escalation (see graph),[1] clinical implementation of these regimens has historically been limited. This is due to toxicity resulting from the large treatment margins common with conventional, gantry-based systems that are unable to account for the respiratory movement of the tumor.




Unlike the gating and breath-holding techniques commonly used in other radiation delivery systems, the CyberKnife® Robotic Radiosurgery System is the only system capable of intelligently tracking respiratory motion in real-time and automatically correcting for any changes in the tumor's position as well as adapting to any changes in the patient's breathing pattern, without user intervention. Additionally, the robotic mobility of the CyberKnife System makes delivery of hundreds of non-coplanar beams practical in routine clinical practice without the need to move the treatment couch during treatment. Ultimately, the combination of these capabilities is offered to the user in a simple and logical workflow that allows clinicians to easily plan sophisticated treatments with radiosurgical margins, dramatically decreasing dose to healthy tissue.



**CyberKnife System**
Lung Radiosurgery



**Gantry-Linac**
Lung SBRT

| | CyberKnife® Robotic Radiosurgery System | Gantry-Linac Lung SBRT |
|---|---|---|
| **Fractionation / Dose** | 12 Gy x 4 fractions, Rx at 73% of maximum | 12 Gy x 4 fractions, Rx at 72.6% of maximum |
| **Dose Calculation Algorithm** | Monte Carlo | Superposition Convolution |
| **Respiratory Motion Management Technique** | Synchrony® Respiratory Tracking System<br>Beams move in real-time with 3D target motion. Patient breathes freely while dose is delivered continuously throughout the respiratory cycle. | Respiratory Gating<br>Beams repetitively turn on and off as the target enters and exits a fixed isocenter. |
| **Treatment Planning System** | MultiPlan® Treatment Planning System | Pinnacle |
| **Total Treatment Planning Time** | 1 hour (excluding contouring) | 2.5 hours (excluding contouring) |
| **Total Door-To-Door Delivery Time Per Fraction** | 45 minutes<br>Includes time required for patient immobilization, alignment, imaging, beam-on, linac traversal, respiratory motion management, and non-coplanar beam delivery. | 50 minutes<br>Includes time required for patient immobilization, alignment, imaging, beam-on, linac traversal, respiratory motion management, and coplanar beam delivery. |
| **Image Guidance Frequency** | 1 set-up image plus 40 intra-fraction adaptive images | 1 set-up image |
| **Total # of Beams** | 116 non-coplanar beams<br>Non-coplanar beams delivered automatically without treatment interruption or patient repositioning. | 7 coplanar beams; 73 segments<br>Interruptions for manual couch rotations, rigorous QA, and risk of gantry-patient collision have resulted in virtually no clinical adoption of gantry-based non-coplanar delivery. |
| **Beam Collimation** | Single 25mm fixed cone | 120 Leaf MLC |
| **Margin Expansion: GTV to CTV** | 3mm (uniform) | 3mm (uniform) |
| **Margin Expansion: CTV to PTV** | 3mm (uniform) | 10mm superior-inferior; 5mm in axial plane |
| **PTV Coverge** | 96% | 93% |

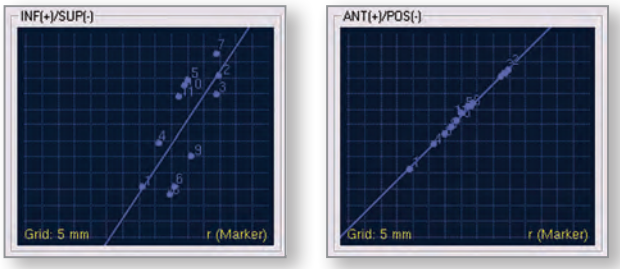
*The patient breathes normally while the CyberKnife System delivers highly collimated beams to the moving target.*

## Simply Intelligent Respiratory Motion Tracking

### Synchrony® Respiratory Tracking System

The Synchrony® Respiratory Tracking System is the only respiratory motion compensation technology that moves the beam *with* the motion of the tumor, thus maintaining a constant beam's eye view throughout the respiratory cycle. As a result, no special patient coaching, breathing apparatus or frame is required — *the patient breathes freely*. In contrast with IGRT techniques utilized on other radiation delivery systems, the Synchrony System intelligently and automatically adapts to changes in target motion thereby eliminating the need for treatment interruptions. With a demonstrated delivery accuracy of better than 1.5 mm,[2-3] physicians no longer have to add large CTV to PTV margin expansions to account for targeting uncertainty, therefore maximally excluding normal tissue from the target volume.

Using patented technology, the patient's respiratory motion is monitored in real time while internal tumor motion is monitored by leveraging the CyberKnife® System's continual image guidance capabilities. The Synchrony System creates a correlation model between these two motion patterns to direct the linac in real time to deliver highly targeted radiation beams focused on the moving tumor. The correlation model automatically updates with each new image acquisition, thereby adapting to any changes in the patient's breathing pattern. Moreover, the entire process from respiratory motion monitoring to correlation model creation and automatically adapting to changes in the patient's breathing can be completed with a single-click of a button on an intuitive user interface.




*Correlation Model is able to accurately track curvilinear target motions in addition to linear motion.*

*"Our site was one of the first to use Synchrony® clinically and, over the years, we have spent a significant amount of time testing the system's accuracy. The ability to track target motion with confidence throughout the breathing cycle allows our physicians to prescribe tighter dose margins and improve dose sparing to surrounding tissues. Synchrony is a unique and powerful tool for management of respiratory motion and we rely on it routinely."*

*Steve Humphries*
*Medical Physicist*
*Rocky Mountain CyberKnife Center, Boulder, CO*

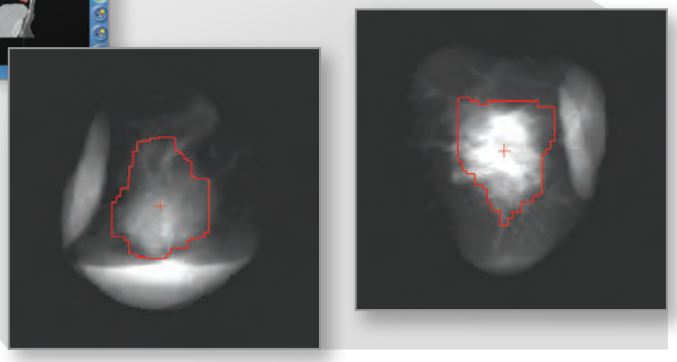
## Radiosurgical Accuracy, No Fiducials

### Xsight® Lung Tracking System

The Xsight® Lung Tracking System delivers the ultimate in soft tissue tracking technology. Unlike other technologies existing in the radiation oncology field, bony anatomy is not used as a surrogate for the target. The Xsight Lung Tracking System utilizes the actual image properties of the lung tumor itself for targeting the beam. By tracking the tumor directly, clinicians can use radiosurgical margins — without the need for fiducials* — to treat lung tumors with confidence while minimizing dose to adjacent healthy tissue. Possessing the intelligence to recognize and correct for both translational and rotational movements of the target, the Xsight Lung System allows the user to target dose precisely to the tumor with radiosurgical accuracy.


*Fiducial-free radiation delivery to a lung tumor wtih radiosurgical accuracy.*


*Treatment planning for the Xsight Lung Tracking System – tumor contour definition in the MultiPlan Treatment Planning System.*



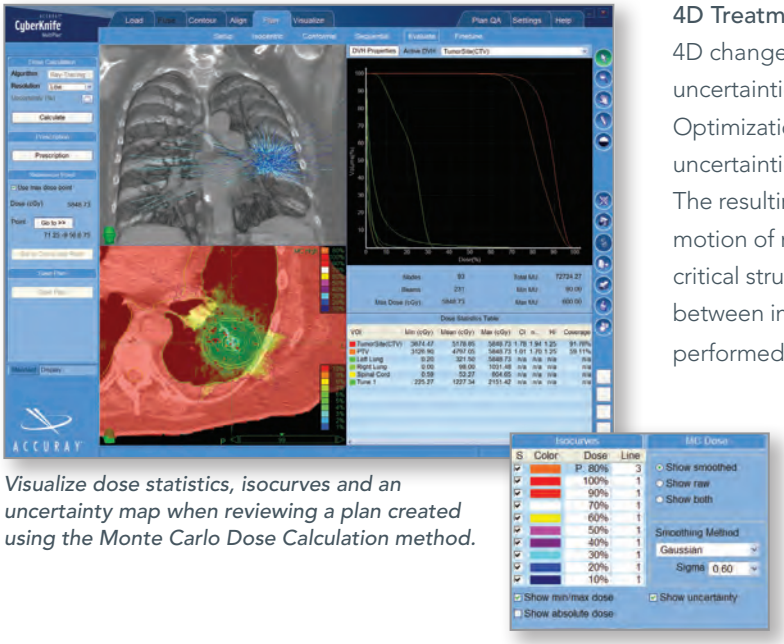
*On-board tools to aid treatment planning and automatic delivery.*

** Limited to tumors of specific size and location*

## Intuitive Design Enabling Expert Level Treatment Planning

### Monte Carlo Dose Calculation

Accurate dose calculation is essential to generating high quality treatment plans for patients who receive radiation treatments. Of the various dose calculation methods available, the Monte Carlo method is widely recognized as the most accurate and is often considered the "gold standard" in radiation dose calculation. By providing results in a time period that is feasible for routine clinical use and incorporated in a logical and intuitive planning workflow, the Monte Carlo Dose Calculation feature in the MultiPlan® Treatment Planning System makes it easy to design and deliver highly sophisticated treatment plans, while ensuring excellent agreement between calculated and delivered dose.




*Visualize dose statistics, isocurves and an uncertainty map when reviewing a plan created using the Monte Carlo Dose Calculation method.*

### 4D Treatment Planning and Optimization System*

4D changes in anatomy during imaging introduce uncertainties into the planning process. The 4D Treatment Optimization and Planning System accounts for these uncertainties in the optimization and planning process. The resulting dose calculation considers the intra-fraction motion of not only the treatment target, but all surrounding critical structures as well. Automatic deformable registration between image series enables true 4D planning to be performed easily and routinely in a clinical setting.

*Review target and 4D motion of the surrounding critical structures.*

References
1. Onishi H, Araki T, Shirato H, Nagata Y, et al. Stereotactic hypofractionated high-dose irradiation for stage I nonsmall cell lung carcinoma: clinical outcomes in 245 subjects in a Japanese multiinstitutional study. Cancer. 2004 Oct 1; 101 (7): 1623-31.
2. Data on file.
3. Hoogeman, M., Prevost, J. B., Nuyttens, J., Poll, J., Levendag, P., and Heijmen, B. Clinical accuracy of the respiratory tumor tracking system of the CyberKnife: Assessment by analysis of log files. Int. J. Radiat. Oncol. Biol. Phys., 74[1], 297-303. 2009.

** CyberKnife System option*

# CyberKnife® VSI™ System

**Robotic Manipulator and Linear Accelerator** – The compact, 1000 MU/min 6MV X-band linear accelerator is capable of being positioned in virtually any direction by a high precision robotic manipulator with repeatable sub-millimeter accuracy.

**Imaging System** – The low-energy X-ray sources and the flush mounted detectors create high-resolution anatomical images throughout the treatment, which are continually compared to previously generated DRR's to determine real-time patient positioning and target location.

**Iris™ Variable Aperture Collimator** – Rapidly manipulates beam geometry to deliver up to 12 beam sizes from each linac position with characteristics virtually identical to that of fixed circular collimators.

**RoboCouch® Patient Positioning System** – Robotically aligns patients precisely with six degrees of freedom, enabling faster patient setup. The Seated Load option enables simple and comfortable loading of mobility-limited patients.

**Xchange® Robotic Collimator Changer** – Automatically exchanges collimators robotically, enabling highly conformal treatments delivered with greater efficiency.

**CyberKnife® Data Management System** – Provides comprehensive storage and processing of the patient data that is generated as the patient progresses through the CyberKnife planning and treatment workflow.

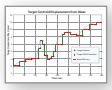
**Report Administration** – The ability to review stored patient and usage data is simple and straightforward with the easy availability of a variety of departmental reports.

**Radiosurgery DICOM Interface** – This interface utilizes the industry-standard DICOM protocol to export patient treatment plan and delivery information to an Oncology Information System.

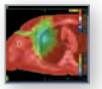
**Synchrony® Respiratory Tracking System** – Continuously synchronizes beam delivery to the motion of the tumor, allowing clinicians to significantly reduce margins while eliminating the need for gating or breath-holding techniques.

**Xsight® Lung Tracking System** – Directly tracks the movement of lung tumors without fiducials while maintaining precision, reliability and self-adjusting repeatability.*

**Xsight Spine Tracking System** – Eliminates the need for surgical implantation of fiducials by using the bony anatomy of the spine to automatically locate and track tumors, making radiosurgery more precise and less invasive.



**InTempo™ Adaptive Imaging System** – Intelligent, adaptive imaging system designed from the ground up to address the unique challenges of prostate tracking resulting from random and excessive target motion.



**Monte Carlo Dose Calculation** – Often considered the gold standard when treating lung tumors, the CyberKnife System's Monte Carlo Dose Calculation produces results in minutes compared to what commonly requires hours or days with other systems.

**Sequential Optimization** – An intuitive and intelligent plan optimization algorithm for rapidly developing custom tailored treatment plans specific to the unique clinical objectives for each patient.

**AutoSegmentation™** – Automatically generate accurate contours for prostate, rectum, bladder, seminal vesicles and femoral heads. Results can be generated using both CT and MR image information, and require minimal user input.

**QuickPlan™** – A complete treatment plan is generated automatically, and the results presented to the user for review. The entire planning process, including the setting of planning parameters, optimization, and dose calculation, is automated. Plans are generated using the clinical objectives predefined by the user.

** Limited to specific tumor size and location*

For more information on the CyberKnife Robotic Radiosurgery System, please contact Accuray Incorporated.

www.accuray.com

sales@accuray.com

*The CyberKnife System and CyberKnife options may not be available in some countries. Specifications, features and functionality subject to change without prior notification. For a complete list of CyberKnife Systems and options available, please contact Accuray at* ***sales@accuray.com.***

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ACCURAY®


**UNITED STATES**

**Accuray Corporate Headquarters**
1310 Chesapeake Terrace
Sunnyvale, CA 94089
USA
Tel: +1.408.716.4600
Toll Free: 1.888.522.3740
Fax: +1.408.716.4601
Email: sales@accuray.com

**TomoTherapy**
1240 Deming Way
Madison, WI 53717
USA
Tel: +1 608 824 2800
Fax: +1 608 824 2996

**ASIA**

**Accuray Japan K.K. - Tokyo**
Daini Tekko Building 6F
1-8-2 Marunouchi, Chiyoda-ku
Tokyo 100-0005
Japan
Tel: +81.3.6269.9556
Fax: +81.3.3217.0337

**Accuray Asia Ltd. - Hong Kong**
Suites 1702 - 1704, Tower 6
The Gateway, Harbour City
9 Canton Road, T.S.T.
Hong Kong
Tel: +852.2247.8688
Fax: +852.2175.5799

**Chengdu Twin-Peak Accelerator Technology**
#39 Huatai Road, Longtan Industrial Zone,
Section 2 East, 3rd Ring Road,
Chengdu, Sichuan 610051
China

**EUROPE**

**Accuray Europe**
Tour Atlantique 25e
1 Place de la Pyramide
92911 Paris La Défense Cedex
France
Tel: +33.1.5523.2021
Fax: +33.1.5523.2039

**Tomotherapy Belgium BVBA**
Pegasuslaan 5
1831 Diegem
Belgium
Tel: +32 (0)2 400 4400
Fax: +32 (0)2 400 4401/02