THE MULTIPURPOSE SOLUTION FOR EFFICIENT PATIENT MONITORING
A COMPLETE SOLUTION FOR PATIENT MONITORING INTEGRATED IN THE WORKFLOW OF THE RADIOTHERAPY CLINIC

C-RAD Sentinel™ is a new advanced system for surface contour localization and monitoring of the patient in the radiotherapy treatment process. As the development of treatment techniques has enabled higher levels of accuracy in the treatment with higher doses there is also an increasing demand for better accuracy in monitoring the patient position and movements. The C-RAD Sentinel basic platform is based on advanced laser technology with multipurpose software modules covering different tasks in the treatment procedure. The different software modules are seamlessly integrated with other systems in the clinic. C-RAD Sentinel is designed to provide a high level of ease of use combined with improved accuracy.

The Sentinel system does not require any markers to be placed on the patient or the couch, and doesn’t subject the patient to any additional radiation. This also means that the personnel can stay in the treatment room during the whole set up procedure.

C-RAD Sentinel offers solutions for fast patient positioning with a high level of accuracy, motion detection during the treatment delivery procedure, respiratory gating functionality and furthermore advanced applications like image fusion and adaptive radiation therapy.

C-RAD SENTINEL PROVIDES
• Connectivity  Seamless integration with other systems in the RT clinic
• Accuracy  High level of accuracy based on state-of-the-art laser technology
• Ease of use  No need for manual marking or maneuvering of the patient – enables timesaving in the patient positioning procedure
• Confidence  The system confirms correct positioning and monitors movement
By seamlessly integrating with the systems and workflows already in place, C-RAD Sentinel makes it possible to ensure precision throughout the whole radiation therapy process, while at the same time minimizing the amount of work necessary to operate the system.

**DIAGNOSTICS**
High quality diagnostic imaging is the foundation of the radiation therapy process, and its importance is growing even more with the adoption of advanced treatment delivery methods such as 3D-CRT (3D-Conformal Radiation Therapy), IMRT (Intensity Modulated Radiation Therapy) and ART (Adaptive Radiation Therapy).

In many cases, one imaging modality is not enough to get the complete picture. The solution is image fusion, a process in which the volumetric images from multiple imaging modalities such as CT, MR, PET and SPECT are co-registered to a common coordinate system. The final result is a combined data set that will give the maximum information possible to assist the oncologist in the critical decision on which form of therapy should be chosen for subsequent treatment.

To further increase the image quality, respiratory gating can also be used at this stage for prospective or retrospective gating of the data acquisition procedure, which will minimize any breathing motion artifacts and, in the case of retrospective gating, facilitate reconstruction of a complete 4D data set.

**TREATMENT PLANNING**
Once the treatment planning has been performed, the resulting plan can be transferred to the Sentinel system through import from the industry-standard DICOM format.

If the external patient outline was traced by the treatment planning system, this data can also be imported and used as reference data for performing patient positioning at each fraction.

The Sentinel system can also, depending on the capabilities of the treatment planning system, provide the information needed for adaptive radiation therapy – by aggregating the systematic and stochastic errors in patient position for the already delivered fractions.
**SIMULATION**

In the case of conventional simulation, the Sentinel system can be used for initial patient positioning based on the reference data coming from the treatment planning system, while motion detection helps ensure that the patient doesn’t move during the simulation session.

When the correct patient position has been verified, reference data can be acquired for patient positioning during the upcoming fractions.

For patients to receive gated treatment, respiratory gating during the simulation session is used to ensure that the gating parameters established earlier are still valid.

**TREATMENT DELIVERY**

In the treatment room, synchronization with the LINAC or R & V (Record and Verify) system ensures that the correct reference data is called up automatically when the patient is selected for treatment, and also eliminates the need for any manual selection of the patient in the Sentinel system.

Patient positioning before the actual treatment begins, together with subsequent motion detection, ensures that the patient’s position is correct both before and during the whole treatment delivery.

If respiratory gating is used, the treatment will be synchronized to the patient’s respiratory cycle so that more dose can be delivered to the tumor, while the surrounding healthy tissue is spared. C-RAD Sentinel uses no physical markers for gating, and eliminates the need for cumbersome extra equipment in the treatment room.

**ADAPTIVE RADIATION THERAPY**

In adaptive radiation therapy, the information gathered by C-RAD Sentinel is fed back to the dose planning system, so this can produce accurate modified plans. The system collects and aggregates the information on the actual positioning of the patient during the performed fractions, allowing the dose planning system to compensate for any possible previous errors.
C-RAD Sentinel is an advanced laser/camera-based system which can be used for patient positioning as well as for motion detection, respiratory gating, image fusion and adaptive radiation therapy functionality.

**LASER SCANNER**
The hardware consists of a single scanner unit containing the laser and camera, mounted in the ceiling in front of the gantry. The scanner is connected to the PC running the c4D software.

During patient surface acquisition, a laser line is swept along the patient while the camera records a number of images. From the data acquired, a complete 3D surface of the patient can be reconstructed using laser line triangulation.

For patient positioning, the acquired surface is captured in a few seconds and can contain several hundred contours. For motion detection and respiratory gating the number of contours are typically lowered so that the desired frame rate is achieved. The system is capable of acquiring more than 50 contours per second.
**c4D SOFTWARE**
The c4D multi-application software supports all modes of operation in one integrated package. Great efforts have been made to make the software as user-friendly as possible, requiring a minimum of user interaction in the daily clinical workflow, while providing the advanced user with sophisticated data management, analysis and reporting functionalities.

The software is designed to integrate seamlessly with existing systems at the clinic, such as CT, MR and PET equipment, as well as with treatment planning systems, linacs and R&V systems, and with motorized couch tops.

**cPOSITION**
By advanced surface registration algorithms the actual patient position is compared to a predefined reference position/image. With a click of a button the results are obtained and the need for manual markings on the patient and for manual handling to bring the patient into the defined position is eliminated. With interface to major accelerator vendors the suggested patient position is transferred to the respective couch control system and fast and accurate alignment is achieved.

**cMOTION**
During the treatment delivery phase it is critical that the patient does not change position and that the treatment is delivered in accordance with the plan. cMotion monitors the movement of the patient during treatment delivery and automatically warns if the patient moves outside the allowed tolerances. This eliminates the need for visual monitoring by the staff, adding convenience as well as safety.

**cRESPIRATION**
In some treatment procedures the location of the tumor is moving as a result of normal respiration. In order to adjust for this the treatment planning can choose to use a larger target volume, with the side effect that healthy tissue is also affected, or choose treatment based on respiratory gating. With respiratory gating the treatment delivery is synchronized with the patient’s respiration phase. cRespiration allows respiratory gating without markers and any cumbersome extra equipment in the treatment room.

**cADAPTIVE**
Collects and prepares information on the actual positioning of the patient during the performed fractions, allowing the dose planning system to compensate for any possible previous errors when preparing plans for adaptive radiation therapy.

**cFUSION**
Radiotherapy treatments today include a number of different imaging modalities such as CT, MR, PET and SPECT. The use of these systems often varies between clinics. With cFusion C-RAD will offer a unique solution for image fusion by combining information from these various imaging modalities.
C-RADS MISSION IS TO IMPROVE CANCER CARE BY OFFERING INNOVATIVE PRODUCTS AND SOLUTIONS TO THE RADIATION THERAPY MARKET

C-Rad develops and manufactures innovative products and solutions that help our customers take advantage of new advances in the radiation therapy field.

The company was founded in 2003, by a group of experts from the radiation therapy industry and The Karolinska Institute in Stockholm. The C-Rad Sentinel™ system has been developed in close cooperation with leading radiotherapy clinics.

The company is located on two sites in Sweden, Uppsala and Frösön. The group head quarter is located in Uppsala, which also is the base for the Sales and Marketing group as well as the group developing the C-Rad Sentinel system, while all development of the new advanced 2D detector, based on GEM technology, is done at Frösön.