

# Respiratory gating





## Respiratory gating

C-RAD is proud to present the next generation respiratory gating solution based on the advanced Sentinel™ and Catalyst™ optical surface tracking technologies.

Functionality for retrospective (4D CT) and prospective gating is supported, requiring only one Sentinel™ laser scanner system in each CT room. Similarly, gated treatments are supported by installing one Catalyst™ system in each treatment room. (Exact functionality is depending on availability of the specific interfaces.)

The C-RAD optical gating solution requires no fiducials or markers, and is designed to ensure that the same points on the surface are automatically tracked at every fraction. The design offers seamless support throughout the entire CT simulation, treatment planning, and delivery phases of the radiation therapy process.

Calibrated to isocenter in each vault, both the Sentinel™ and Catalyst™ work in the absolute room coordinate system, alerting the operator to all externally detectable baseline shifts instantly. The solution offers support for several techniques such as deep-inspiration breath-hold, free breathing, coached breathing etc. Furthermore are there functions included for immediate detection of irregular breathing and patient motion, ensuring

maximum safety during the critical treatment delivery.

The C-RAD gating solution is based on the principle of direct optical triangulation, yielding very low latencies for improved precision and safety during gated imaging and treatment delivery. The patients are not exposed to any additional dose for tracking the respiratory motion.

The combined Sentinel™/Catalyst™ system offers the following advantages compared to other available solutions for respiratory gating:

- No markers or other equipment to be placed on or around the patient.
- Tracking of both thoracic and abdominal motion, performed continuously and in parallel which is necessary in order to both establish and subsequently verify the correlation between external (surrogate) and internal (target) motion.
- Direct optical triangulation measurements, providing sub-millimeter accuracy at each detected point with low sensitivity to ambient light.

The end result is a complete gating solution for CT and linac with optional capabilities for patient se-up and positioning, general intra-fraction motion detection and other advanced applications – without the need to install any additional hardware.

# Go with the flow

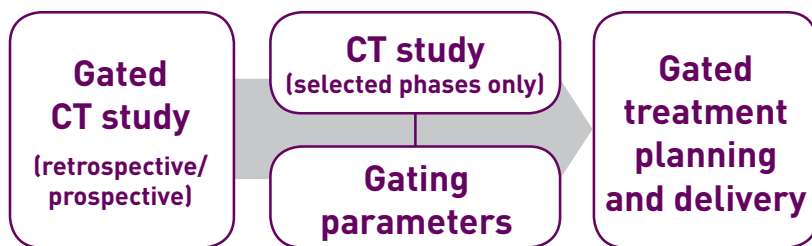
Gated treatment delivery is based on a gated planning CT study, which establishes the correlation between the external and internal motion. The CT study can be gated in either prospective or retrospective mode.

## Prospectively gated CT study

During prospective gating of the CT, the patient's respiratory motion is monitored and the CT will only acquire images when the respiratory signal is within a predetermined gating window. Prospective mode is used when the appropriate breathing state is known beforehand (e.g. deep inspiration breath hold technique). This saves patient dose and simplifies treatment planning because, as in the case of non-gated treatments, only a 3D volumetric data set needs to be considered.

## Retrospectively gated CT study (4D CT)

In case of retrospective gating (aka 4D CT), the captured CT slices will be sorted according to their respective respiratory phase and the final data set will contain multiple volumetric images, clearly showing how the patient's anatomy is changing through the whole breathing cycle. The phases most appropriate for treatment delivery is then selected. The relevant CT volumes are aggregated, either by the CT workstation software or the treatment planning system, into a single 3D volume for subsequent treatment planning.



## Gated treatment planning and delivery

Based on the planning CT study (either retrospectively or prospectively gated), treatment planning is then performed. In the treatment room, the patient's respiratory motion is monitored and the treatment beam will be turned on only when the signal is within the already established gating window.

In addition to being part of the C-RAD gating solution, the C-RAD Catalyst™ also includes many other functionalities:

The **motion detection** functionality of Catalyst™ monitors the patient for possible movements without the use of any markers or fiducials and generates an alarm or beam-hold in case the patient moves outside of set limits. Through advanced non-rigid registration algorithms, the isocentric shift is continuously computed. This provides increased confidence while at the same time minimizing the risk of false alarms.

The advanced **patient set-up and positioning** functionality of Catalyst™ offers a workflow oriented tool for the RT-department to increase the accuracy in combination with higher efficiency in the often time consuming patient set-up and positioning procedure. Posture errors are projected directly onto the patient as a continuously updated distance map, providing unique ergonomic benefits.



# About Respiratory Gating

Advances in radiation therapy during the past few decades has enabled delivery of highly conformal treatment plans through techniques such as IGRT, IMRT and IMAT. These developments provide the potential of curing more cancer patients with less side effects. However, even today most treatment plans are still based on a single, static, 3D planning CT dataset. Respiratory-induced motion therefore remains one of the major challenges when treating targets in the thoracic and abdominal region. Respiratory gating offers a solution by synchronizing beam delivery to the patient's breathing. The beam will be turned on only when the target is in the correct position according to the treatment plan. This enables more dose to be delivered to the target volume while sparing surrounding healthy tissue and protecting organs at risk.

**Works in progress. Not for sale in the US.**

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