4D CT cookbook 2.0

A guide to 4D CT imaging in RT

siemens-healthineers.com/radiotherapy
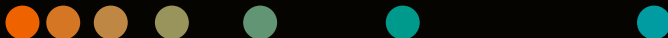
For
SOMATOM
CT users

SIEMENS
Healthineers

Foreword

Because organs move with the respiratory motion, CT images of the chest and abdomen may contain artifacts that create problems with reproducibility and image interpretation.

The organs in the chest and abdomen move periodically and repetitively according to respiratory motion. Image artifacts and treatment risks can be avoided if respiratory motion can be precisely detected and if synchronized imaging or irradiation is available.

Especially when a linear accelerator is used for tumor treatment, normal tissue around the target may be unnecessarily exposed to radiation if the tumor is located in a moving organ.

This is because the field of irradiation must be wider than the actual size of the target to account for the target's motion. Patients can benefit from precise margins or "mid-vent" dose planning.

Addressing the challenge of motion in radiation therapy is a key factor in the continuum of cancer care and External Beam Radiation Therapy (EBRT).

This booklet describes current solutions and tips and tricks to implement 4D imaging in the clinical routine. We encourage you to offer feedback that will help us support the fight against cancer.

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Content

Breathing recording system

Motivation

The image quality of a 4D CT dataset depends largely on accurate scan parameters (see the "Acquisition" section) and good synchronization between the acquisition and the patient's breathing curve. To help achieve high image quality, devices are used to track and record the patient's breathing and provide this information to the user and the CT scanner.

Technologies

Respiratory gating/ signal detection

There are different breathing recording systems available on the market that use different technologies. Here are some **examples**[1]:

- RPM/RGSC (Varian Medical Systems) Infrared tracking camera
  and a reflective marker block placed on the patient
- Anzai (Anzai Medical)
  Mechanical detection using an elastic belt around the patient with a pressure sensor
- Sentinel 4D CT (C-RAD)
  Laser-based optical detection of thoracic excursions
- GateCT (Vision RT)
  Surface guidance technology with tracking of the patient via single stereo camera unit

The most commonly used are optical detection systems, because some patients are uncomfortable wearing a belt around the thorax or abdomen or breathing into a spirometer.

Positioning

- The marker block's position should be "flat" (i.e., not tilted) because many lung cancer patients don't have sufficient thorax motion to produce a safe and robust signal (amplitude of more than 2–3 mm).
- The block should be positioned caudally from the sternum (as close as possible) and sufficiently near the target. Try to find the best location for the strongest signal. "Strongest signal" is depending on the patient's way of breathing. This can be below the sternum on the abdomen/belly or on the lower part of sternum.

Tips and tricks
- Some systems require an accuracy check and – if needed – a calibration prior to the first procedure each day. This procedure must be performed prior to patient setup on the table.
- Make sure that the marker block is visible in the tracked area throughout the entire scan.
- Make sure to mark the position of the block in a way that it can be placed at the exact same spot for accurate rescan or gated treatment.

Figure 1:
Positioning the marker block

Figure 2:
Example of patient positioning

[1] *The information shown herein refers to products of 3rd party manufacturers and thus are in their regulatory responsibility. Please contact the 3rd party manufacturer for further information.*

Patient selection

Motivation

Even with modern scan and reconstruction techniques, 4D CT scans are prone to artifacts and uncertainties in the observed tumor motion. In the worst case, the scan has to be aborted and then repeated, leading to extra dose for the patient. Patient selection and optional breathing training are important factors in reducing these problems.

Patient condition checklist

Patients with the following conditions are less suitable for a 4D CT:

- Patients who feel uncomfortable lying down for long periods
- Patients with pathological respiration patterns: for example, Biot's ataxic breathing, Cheyne-Stokes
- Patients with very long respiration periods (less than six breath cycles per minute)
- Patients with frequent severe coughing, or who are very fatigued and fall asleep during the exam
- Patients who breathe too fast (i.e., 30 bpm) → training is needed to breathe reasonably fast

Breathing curve evaluation and examples

The breathing curve should be monitored on the breathing curve recording system or at the scanner console if a compatible device is used (Varian or Anzai). If any of the factors below occur, there may be many image artifacts.

- Is the amplitude too low? (**3A**: ideal breathing curve, **3B**: amplitude too low)
- Is there significant irregular breathing during the 4D recording? **(3C)**
- Does coughing occur during 4D CT recording? **(3D)**
- If a quality indicator is available, does it show poor periodicity? **(3E)**
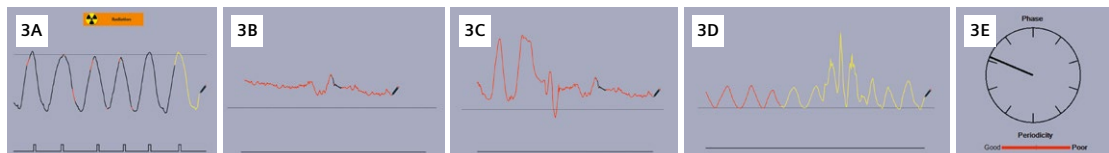
Tips and tricks
- It's important that the patient's breathing pattern is fairly regular, and coaching may make their breathing pattern more regular and lead to good 4D CT images.
- If the patient is coached for the 4D CT, coaching should be repeated for the treatment situation. Otherwise, systematic errors can be introduced: for example, the anatomy shown in the 4D CT will not represent the anatomy at treatment. If coaching is not offered, tell the patient to relax and breathe normally.
- A trial run before the scan is recommended: for example, how the table moves, how automatic patient instruction is provided.
- The optimal setup for the breathing curve recording system should be performed for the best quality indicator and amplitude. Some systems have a feature that coaches the patient: the patient can watch their breathing curve on a screen and try to follow a defined pattern.
- Some devices offer visual feedback to patients e.g. via a screen that can be used for training but also during examination. This direct feedback could help the patient to stay relaxed and guides the breathing procedure well (for example, via the Varian VCD (Visual Coaching Device)).

Acquisition

Motivation

The selection of the right acquisition technique and scan parameters are crucial in order to minimize artifacts and to provide the right type of image needed for subsequent treatment planning. We describe both conventional and adaptive acquisition along with their respective pros and cons.
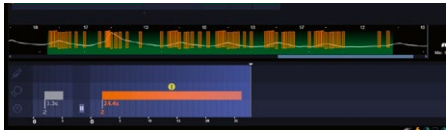
Conventional 4D CT (spiral scan)

Figure 4A:
Example of a 4D spiral scan

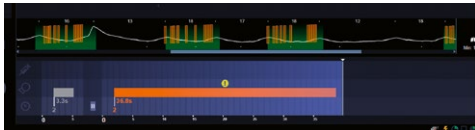**4D CT with Direct i4D[1,2,3] (adaptive sequential scan)**

Figure 4B:
Example of a scan with Direct i4D

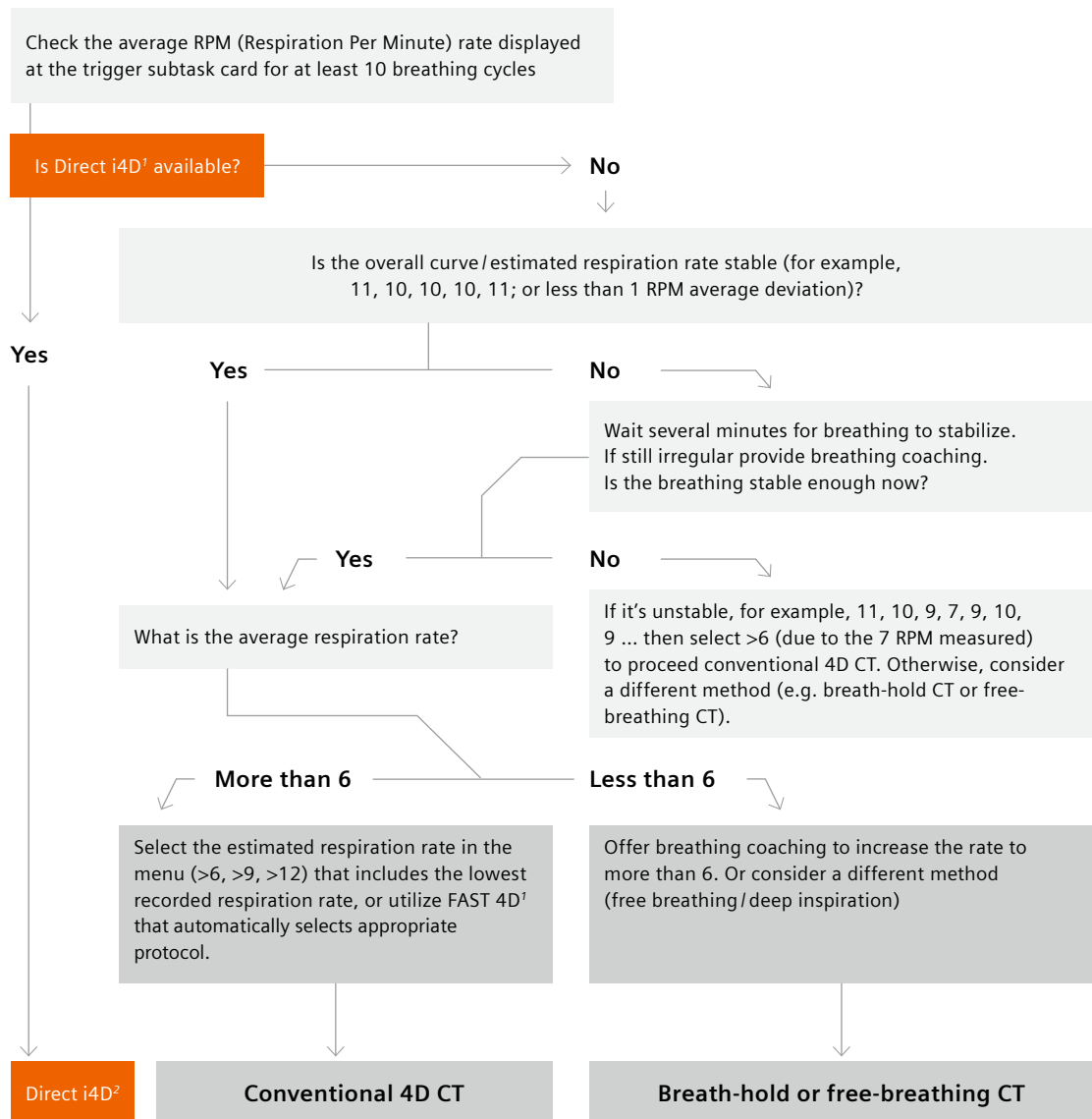|		
Radiation dose	Comparable dose between Direct i4D and 4D spiral scan	
Scanning approach	No adaption	Fully adaptive to patients breathing frequency and amplitude
Recon-struction	No adaptation in reconstruction	Adaptive reconstruction based on average amplitude and average breathing cycle
Result	Sensitive to variation in breathing patterns [3]	Robust against variation in breathing patterns. Reduces 85% of artifacts caused by the acquisition of an incomplete breathing cycle. [1]

Scan protocol

When a conventional scan protocol is selected (for example, RT_Resp), the estimated respiration rate ("Est. respiration time") plays an important role in setting the scan parameters (e.g. pitch and rotation time for spiral scanning). If these parameters are set correctly, every voxel is scanned for at least one breathing cycle. Scanning too fast can result in incomplete breathing cycle information.

[1] Direct i4D is the world's first intelligent 4D CT technology that adapts to the patient breathing, exclusively available for selected scanners.
[2] Systematic shift of the whole respiratory curve to a higher or lower position over many breathing cycles.
[3] Table mounted RGSC is recommended to minimize baseline drift compared to other methods (e.g. wall mounted camera).

Respiratory motion management decision tree

After registering the patient, it's important to select the correct estimated respiration when using conventional 4D CT scanning. The decision tree helps to obtain an accurate acquisition from among conventional 4D CT scanning and adaptive 4D CT scanning (Direct i4D).

Check the average RPM (Respiration Per Minute) rate displayed at the trigger subtask card for at least 10 breathing cycles

Is Direct i4D[1] available? → No

Yes

Is the overall curve / estimated respiration rate stable (for example, 11, 10, 10, 10, 11; or less than 1 RPM average deviation)?

Yes — No

Wait several minutes for breathing to stabilize. If still irregular provide breathing coaching. Is the breathing stable enough now?

Yes — No

What is the average respiration rate?

If it's unstable, for example, 11, 10, 9, 7, 9, 10, 9 ... then select >6 (due to the 7 RPM measured) to proceed conventional 4D CT. Otherwise, consider a different method (e.g. breath-hold CT or free-breathing CT).

More than 6 — Less than 6

Select the estimated respiration rate in the menu (>6, >9, >12) that includes the lowest recorded respiration rate, or utilize FAST 4D[1] that automatically selects appropriate protocol.

Offer breathing coaching to increase the rate to more than 6. Or consider a different method (free breathing / deep inspiration)

Direct i4D[2]　　Conventional 4D CT　　Breath-hold or free-breathing CT

[1] FAST 4D automatically estimates the breathing rate to adapt protocol (e.g. rotation time)
[2] Direct i4D is the world's first intelligent 4D CT technology that adapts to the patient breathing, exclusively available for selected scanners.

Tips and tricks
- Some breathing recording systems allow an online display of the breathing curve on the CT system; other systems require the breathing curve to be imported in order to reconstruct the breathing phases. Direct i4D requires a system capable of online display of the breathing curve in order to adapte the scan in real time.
- On most SOMATOM CT scanners, it's sufficient to enter the patient's respiration rate; the scanner then automatically calculates the optimal pitch / rotation time combination.
- Please keep in mind that importing the breathing curve is required with an open interface.
- The breathing curve should be given the patient's ID on the breathing recording system. This allows the file to be easily found and identified in systems where a manual import is required (this isn't required for the online methods).
- If a Varian device is used with an open interface, we recommend recalculating the peaks on the Varian device by checking "Automatic phase recalculation" and then using time-based reconstruction on the Siemens Healthineers CT.
- SOMATOM CT systems with FAST 4D automatically detect the respiration rate from selected breathing recording systems and set the optimal scan parameters accordingly requires online mode, set above.

Direct i4D[1]

Werner et al [1] describe a novel 4D CT acquisition called Direct i4D. This intelligent 4D CT sequential acquisition adapts to the patient's breathing pattern in real time. This helps to address the following challenges:

1) Irregular Breathing Frequency
When the breathing frequency is too irregular, there can be artifacts related to the acquisition of an incomplete breathing cycle. This happens when there was an incomplete breathing cycle acquired for every position of the patient.
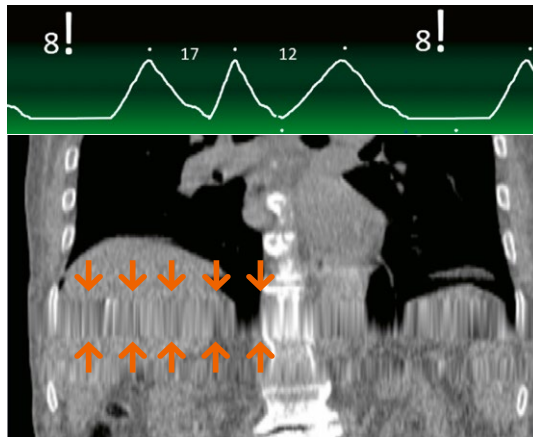
Figure 5:
Interpolation artifacts with conventional 4D CT spiral
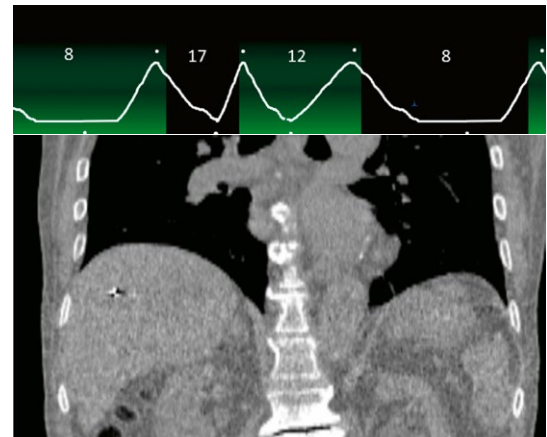
Figure 6:
Scan with Direct i4D (simulated)

Conventional 4D CT
With the conventional 4D CT, the respiratory curve is just recorded in parallel to acquisition. Scan duration at every position is fixed. (e.g. 5s ≙ 12 bpm) When the breath rate drops to e.g. 8 bpm (≙ 7.5 s cycle length) artifacts which origin from incomplete breathing cycles (e.g. interpolation artifacts) cannot be avoided.

Direct i4D
Direct i4D monitors and analyzes the respiratory curve of the patient online. Direct i4D adapts the scan duration (x-ray on time) to the current patient breathing frequency in real time to assure that a complete breathing cycle is acquired at every position.

[1] Direct i4D is the world's first intelligent 4D CT technology that adapts to the patient breathing, exclusively available for selected scanners.

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2) Irregular Amplitude

When the breathing amplitude is too irregular, there can be artifacts originating from variation in breathing amplitude (e.g. stack artifacts). This happens when there are, for example, shallow breathing cycles or very deep inspiration cycles in the breathing patterns of the patient.
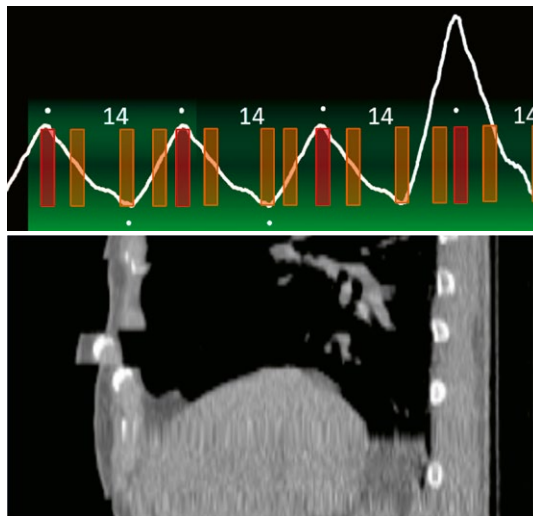

Figure 7:
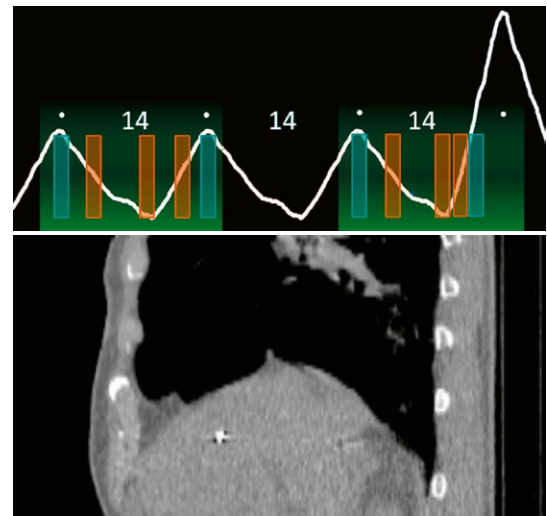Interpolation artifacts with conventional 4D CT spiral

Figure 8:
Scan with Direct i4D (simulated)

Conventional 4D CT

In conventional 4D CT the scan does not react to the patients breathing amplitudes. Moreover the multiphase reconstruction of conventional 4D CT does not account for irregular breathing amplitudes of the patient. Stack artifacts and double structures are the consequence.

Direct i4D

Direct i4D recognizes online the patients average breathing amplitude and adapts the acquisition to that. Moreover, the intelligent multiphase reconstruction of Direct i4D evaluates how the patient was breathing on average and adapts the reconstruction accordingly.

"Direct i4D simplifies the 4D CT workflow and produces excellent results even for patients with irregular breathing patterns. Therefore, it helps to determine the best possible individual dose plan for RT."

Peter Albeck Qvistgaard
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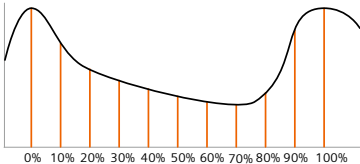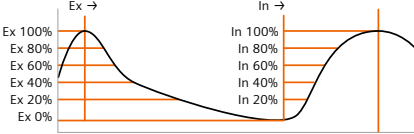
Reconstruction

Motivation

Reconstruction can be challenging due to patient's different respiration patterns. Inappropriate reconstruction parameters could cause changes in tumor location between the reconstructed phases due to image artifacts.

With Direct i4D, the intelligent multiphase reconstruction evaluates how the patient was breathing on average and adapts the reconstruction accordingly to address patient's different respiratory patterns.

Gating parameters

CT scanners from Siemens Healthineers offer two approaches for sorting images. Below we list their pros and cons. For example, time-based reconstruction has been applied to stereotactic body radiation therapy (SBRT) planned on the mid-ventilation phase.
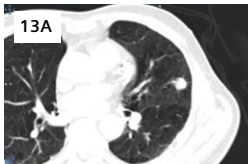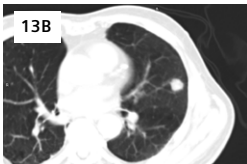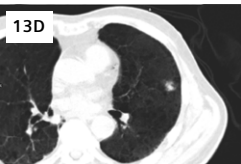
	Sync Adjust	Possible devices	Technique, pros and cons
% (Time based Reconstruction) 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%	✓	Anzai Varian RPM / RGSC	👍 The breathing cycle is divided into equal time points.
			👍 Closely depicts the actual movement over time.
			👍 Allows calculation of midventilation phase.
			👎 Prone to breathing irregularities or inconsistent breathing patterns that leads to 4D CT artifacts.
% In, % Ex (Amplitude based Reconstruction) Ex → In →	✓	Anzai Varian RPM / RGSC	👍 The breathing cycle is divided into equal sections according to the signal amplitude.
			👍 Overall artifacts are fewer when the patient has irregular breathing pattern.
			👍 Maximum exhalation phase can be directly reconstructed.
			👎 Not possible to read the actual movement of the tumor over time.
			👎 Not suitable for midventilation phase.

Reconstruction parameters

Two different reconstruction tasks are typically used in the 4D CT daily routine. The first is the Average CT. The Average CT is calculated based on the whole 4D CT (raw) dataset and represents the blurred motion image over the respiratory cycle. The second commonly performed task is to reconstruct the individual phases of the 4D CT dataset. We recommend 10 phases to be reconstructed in order to cover the entire respiration cycle.

Kernel	B30 / Qr40
Window	Mediastinum
FOV	500 mm / 600 mm (if needed)
Slice thickness	1.5 mm
Increment	1.5 mm
iMAR	Depends on the implants • Pacemaker • Spine implants • Thoracic coils • Shoulder implants

4D image types, advantages and disadvantages [2]

4D Average CT; calculated as the average HU value over the different 4D phases.	T-MaxIP; calculated as the highest HU value over the different 4D phases.	T-MinIP; calculated as the minimum HU value over the different 4D phases.	Gated phase (e.g., 10 phases from 0 – 100%)
Pros: HU stable, commonly used for dose calculation.	Fastest form of delineation, highlights tumors that are hyperdense compared to the surrounding tissue.	Indicates position of tumor at all times.	Excellent view of tumor motion, sharp image for target delineation. ITV for more accurate contouring results than T-MaxIP.
Cons: • Motion blurring • Not appropriate for target delineation. • Using only Average CT for contouring could underestimate the tumor motion excursion.	Less accurate than the 10-phase overlap approach (ITV). Dose calculation is less accurate than Average CT.	Not for dose calculation.	Not as smooth as Average CT because noise level is higher unless higher exposure is applied.

Contouring target and organs-at-risk (OAR)

Motivation

After the reconstruction of the 4D CT dataset, the next step will be to contour the target volume and any relevant organs-at-risk. Traditional tools often require the user to contour slice-by-slice and phase-by-phase.

This time-consuming process can be speeded up with state-of-the-art tools that use pre-processing for OAR contouring and propagation of contours across phases for fast target delineation. Modern tools can also offer insights into tumor movement patterns and help identify the midventilation phase. The workflow described here is based on use of *syngo*.via RT Image Suite.

Automatic preprocessing

With *syngo*.via RT Image Suite, the following steps are already completed by pre-processing before the case is even opened. For more details, please refer to the *syngo*.via or scanner user manual regarding setup of automatic preprocessing.
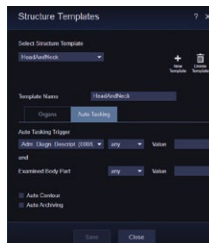

Figure 14A:
The correct structure template is automatically selected at the scanner.
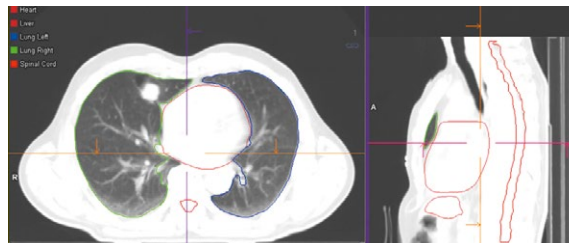
Figure14B:
Once the scan is finished, auto-contouring is triggered and contours are ready when the study is opened in *syngo*.via.
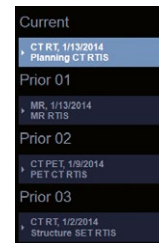
Figure 14C:
Has a previous study already been performed? If so, the previous dataset is automatically loaded in the series navigator (remote prefetching).

What 4D images are used? [2]

The selection of the dataset for contouring largely depends on the motion mitigation technique that will be used in the treatment, (free-breathing, gated, breath-hold). Below is an overview of the different datasets and their pros and cons.

		Pros	Cons
Retrospective	**T-MaxIP**	• No specific software required • Faster than ITV	• No tumor motion assessment • Not accurate at soft tissue boundaries • Larger PTV (tumor motion included in whole)
	ITV (Internal Target Volume)	• Small tumors and large motion or hysteresis in motion	• Dedicated software needed for fast workflow • Larger PTV (tumor motion included in whole)
	Midventilation [3]	• Smaller GTV & PTV (tumor motion included probabilistically in margins)	• Dedicated software needed for fast workflow • Not suitable with large hysteresis
Prospective	**DIBH (deep inspiration breath-hold)**	• Spare the dose to heart, coronary arteries, and lung due to increased distance between target and heart and to reduced lung density [4] • No specific software required	• Patient compliance ~75%

Midventilation phase

• This represents the tumor in its timeaveraged position over the respiratory cycle. The midventilation approach can help reduce the PTV, leading to potentially decreased toxicity [3]. Studies [5] indicate that, by applying smaller target volume margins, this method can potentially increase the number of patients eligible for SBRT.

Figure 15:
Tumor trajectory curve shows the closest position for Midventilation.

|	
Mid-ventilation phase	• *syngo*.via RT Image Suite visualizes the quantitative 3D tumor trajectory and identifies the phase lying closest to the mid-position, making it an ideal solution for introducing this method into the clinical routine. • Contouring on the mid-ventilation phase and applying appropriate margins for the individual patient's tumor motion can also help with locally advanced cancer patient cases, because the tumors and, thus, the irradiated volumes are large, increasing the risk of toxicity. The margin expansion can then be tailored to what is required for the specific patient, based on the tumor motion.
T-MaxIP	• T-MaxIP is a projection of the highest HU value over the respiratory phases onto a 3D image at each voxel position.
Deep Inspiration Breath-Hold (DIBH)	• DIBH is a technique for scanning immediately after the inspiration plateau is reached. Where spiral scans are used, the entire lung can be acquired during a single breath-hold. • The respiratory gating device is only used for monitoring the respiratory curve.
ITV	• ITV is a "sum" of the GTV from all the phases. Tumor motion is covered with complete accuracy, and further consideration of the treatment strategy may be required for motion mitigation (for example, compression after large motion is indicated in the tumor trajectory).
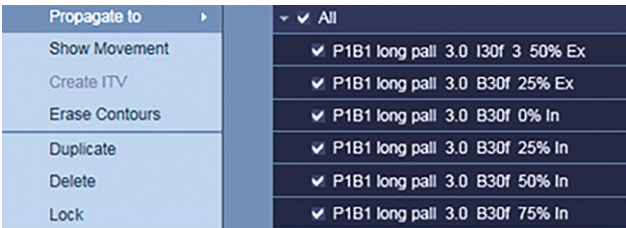
Figure 16A:
After the semi-automated target delineation, contours are propagated to the other phases.
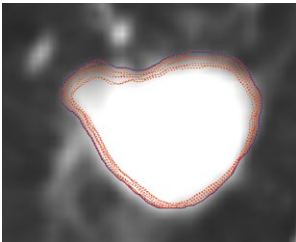

Figure 16B:
After approximately 15 seconds, contours have been propagated and displayed (red dots) along with ITV (blue).

Figure 16C:
Tumor trajectory for further image assessment (e.g., decision support for treatment with a suitable motion mitigation technique, e.g., abdominal compression).

Quality Assurance (QA) for Varian RGSC

Motivation

Quality assurance (QA) tests must be performed to ensure consistent and accurate performance of the Varian RGSC system. Shi et al [6] provide recommendations on daily, monthly, and annual QA of a couch mounted RGSC system based on the author's experience, but also urges clinical physicists to establish their own clinical QA standards which are "optimised for the needs of their clinic and available tools" [1]. With this section, recommendation of QA for RGSC system in conjunction with the SOMATOM Confidence for 4DCT and DIBH treatments are introduced.

Step 1: Calibration (Verification)

The purpose of the calibration is to make sure that the Varian RGSC system receives the correct positioning signal. In this section, the steps of calibration procedure are described for wall / ceiling mounted camera as well as table mounted camera.

**Wall / ceiling mounted camera
(9 points calibration)**

1) To take the couch plane into consideration for calibration procedure, a 9 step calibration is needed.
2) Make sure that the calibration board is aligned to the CT isocenter at point 1.
3) Start calibration program from point 1 to point 9.
4) The system automatically indicates that the calibration has passed or failed. In case of failure, please try again.

**Table mounted camera
(1 point calibration)**

1) Make sure that the calibration board is aligned to the CT isocenter at point 1.
2) Start calibration program for point 1.
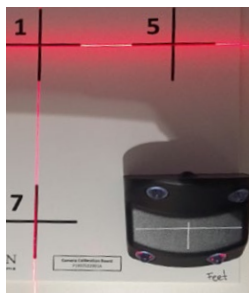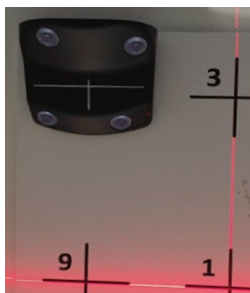3) The system automatically indicates that calibration is passed or failed. In case of failure, please try again.

Figure 17 A, B:
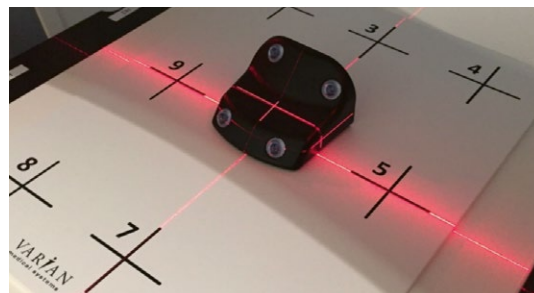Example positions of marker block during calibration in case of 9 points calibration.

Figure 17 C:
1 point calibration in case of table mounted camera. Reflector block is positioned at point 1 on calibration board.

Tips and tricks
- The reflector block is required to be at isocenter height during calibration.
- **It is recommended that the calibration always be performed on a surface that is flat and level with the couch top, such as a flat wooden board.**
- A cardboard box or a foam block can induce an angle on the calibration board. This may introduce calibration errors.
- Check expected positions during calibration. A range of movement (≥3 mm)in vertical position may indicate an expected baseline drift.


Flat board to achieve height

Calibration board placed on un-even foam block

Step 2: Motion learning, period and amplitude

It is intended to check that the RGSC can learn the motion, and the period and amplitude match baselines.

1) Place the marker block on Varian motion phantom at the isocenter.
2) Care must be taken with the positioning of the marker block due to the angulation of the motion platform in the Varian motion phantom.
3) Learn the breathing patterns of the Varian phantom on the RGSC.
4) Guidelines are ~1.6 (± 0.2) cm amplitude and 5.8 (± 0.2) sec period (The period may slower with the low battery level).
5) If the time of the measurement is getting slower than the above, please consider to exchange the new battery.
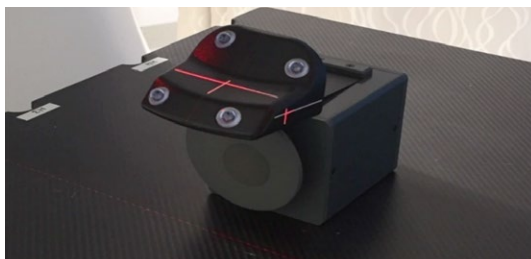
Reflector block on Varian motion phantom

Figure 18:
Learning breathing pattern

Step 3: Baseline drift evaluation

Baseline drift is an effect that the longitudinal position is changed over the table movement. If there is a large (e.g. more than 6 mm) baseline drift, position of the treatment couch shall be adjusted to compensate for the drift so that the changes in the couch position can correspond to the baseline drift in the tumor motion (target margin).

As the baseline drift can be smaller if the direction of table motion coincides precisely with the level of calibration, how to evaluate the baseline drift is described.

1) Use weighted bed if possible in order to reproduce the practical setup.
2) Place reflector block at the isocenter of the external lasers
3) Learn the breathing patterns of the Varian motion phantom on the Varian RGSC.
4) Move the couch into the bore (~600 mm longitudinal move) and wait for 2–3 breathing phases. Do not relearn the breathing pattern.
5) Check the baseline drift described on Varian RGSC user interface and check if the value is less than 2 mm. If the value is higher than that, please reconsider to re-calibrate (step 1).
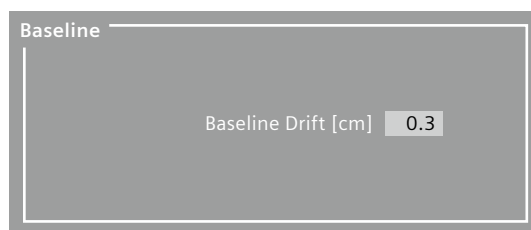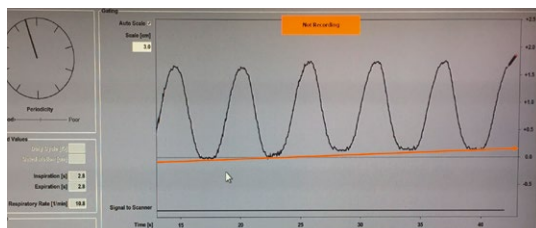

Figure 19: Measurement of the period and amplitude; orange line shows there is a small baseline drift (left).

Check baseline drift with Varian motion phantom:
Hint
- Baseline drift is often unavoidable due to the inherent sag of the CT couch, particularly with patient weight added.
- The user may choose to weight the couch during the calibration to counteract the effect of the patient weight. In this case, the baseline drift would be greater without weight during movement.
- It is important to remember that the Varian RGSC is a surrogate for patient breathing and any baseline drift caused by the CT couch movement will not be seen on the treatment linac.

Step 4: Image reconstruction and Phase binning

The purpose of this step is to make sure that the tracked amplitude displayed on Varian RGSC is corresponding to the amplitude on image reconstruction.

1) Use reflector block on Varian motion phantom. A small marker is placed on the center of the top cross of the reflector block so this position could be seen for measurements.
2) 4D CT Scan for the phantom.
3) Reconstructed with 100% Ex and 0% Ex sagital or coronal (to measure the amplitude) with thin slice (e.g. 2 mm) so that the marker can be visible with less partial volume effect.
4) Open the 100% Ex and 0% Ex series with the Dicom viewer.
5) Use distance tool to measure the distance between surface of the table to the small maker on 100% Ex and 0% Ex
6) Compare the value between motion range displayed on Varian RGSC and measurement Motion Range on Varian RGSC – (100% Ex – 0% Ex) <2 mm

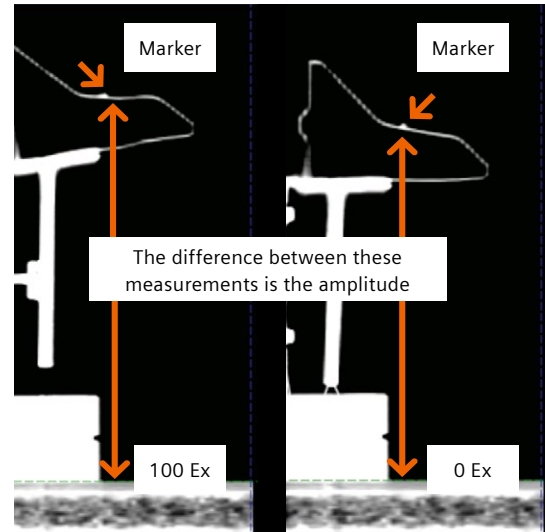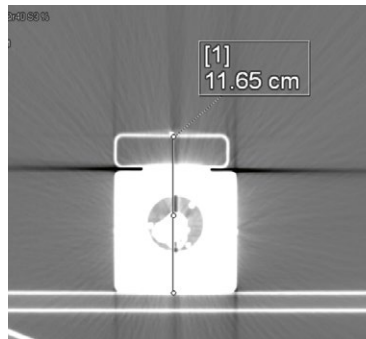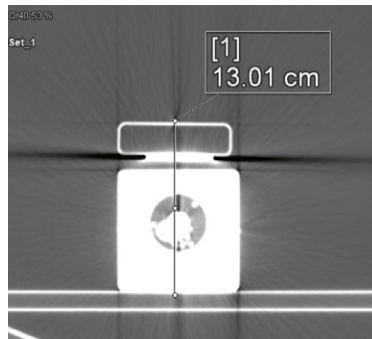If there are more than 2 mm, **please consider re-calibration (step 1)**

Figure 20:
Phase binning amplitude measurement

Example shows the motion range difference between image evaluation and detection from Varian RGSC. In this case, difference in the image reconstruction 13.01 – 11.65 = 1.36 cm Varian RGSC motion range = 1.38 cm

Therefore, the Step 4 is passed in this case.

Hint : Alternative Camera calibration method for wall-mounted or ceiling-mounted cameras

On some scanners the couch doesn't move exactly parallel to the couch top surface, especially when there is weight on the couch. In this case you might observe a baseline drift that increases the further you move the couch inside the scanner bore.

In the following steps we suggest an alternative way of calibrating the wall or ceiling-mounted RGSC camera. Instead of using the calibration board and placing the reflector block on different points on the couch top, the couch is used to reach different longitudinal positions:

Step 1:	Place a reference weight onto the couch top, e.g. 70 kg.
Step 2:	Start the calibration process in the Varian RGSC application.
Step 3:	Place the reflector block into a reference position for the verification, e.g. scanner isocenter or room laser isocenter. > Acquire position 1.
Step 4:	Place the reflector block approximately 10 – 20 cm left and right of the reference position > Acquire positions 2 and 3.
Step 5:	Move the couch at least 20 cm into the scanner bore.
Step 6:	Place the reflector block into three positions with a relative distance of approximately 10 – 20 cm (left, center, right). > Acquire positions 4, 5 and 6.
Step 7:	Move the couch at least 20 cm into the scanner bore.
Step 8:	Place the reflector block into three positions with a relative distance of approximately 10–20 cm (left, center, right). > Acquire positions 7, 8 and 9.
Step 9:	Confirm the calibration.

Conclusion

This booklet attempts to provide guidance for Siemens Healthineers SOMATOM CT users. The information provided is intended to support your entire clinical team in optimizing your workflow and growing your practice, while improving the prognosis for cancer patients throughout the world.

Finally, we look forward to hearing your feedback and suggestions so that we at Siemens Healthineers can continuously support you in delivering excellent care to your patients.

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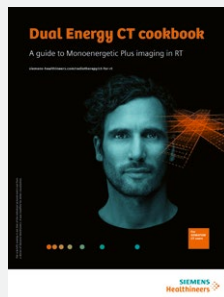
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