HeartView CT
Application Guide

Protocols
Principles
Helpful Hints

syngo **Calcium Scoring**
syngo **InSpace4D**
syngo **Vessel View**
syngo **Argus**

Software Version *syngo* CT 2006A

SIEMENS
medical

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To improve future versions of this Application Guide, we would highly appreciate your questions, suggestions and comments.

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Matrix

	Cardio prospective	Cardio retrospective
SOMATOM Sensation 64	●	●
SOMATOM Sensation Cardiac 64	❍	❍
SOMATOM Sensation 40	●	●
SOMATOM Sensation Open	●	●
SOMATOM Emotion 6	●	●
SOMATOM Emotion Duo	●	–

❍ *Standard*

● *Option*

– *not available*

depending on the system configuration.

Please contact the local Siemens representative for further information.

syngo Calcium Scoring	*syngo* Argus	*syngo* InSpace4D	*syngo* Vessel View
●	●	●	●
❍	❍	❍	❍
●	●	●	●
●	–	●	●
●	●	●	●
●	–	●	●

For further information about the basic operation, please refer to the corresponding *syngo* CT Operator Manual:

***syngo* CT Operator Manual Volume 1:**

Security Package
Basics
SOMATOM LifeNet
syngo Patient Browser
syngo Data Set Conversion
Camtasia
SaveLog

***syngo* CT Operator Manual Volume 2:**

Preparations
Examination
HeartView CT
Respiratory Gating
CARE Bolus CT
CARE Vision CT
syngo Viewing
syngo Filming

***syngo* CT Operator Manual Volume 3:**

syngo 3D
syngo InSpace4D

***syngo* CT Operator Manual Volume 4:**
syngo Dental CT
syngo Osteo CT
syngo Volume
syngo Dynamic Evaluation
syngo Neuro Perfusion CT
syngo Body Perfusion CT

***syngo* CT Operator Manual Volume 5:**

syngo Argus
syngo Calcium Scoring
syngo Vessel View

***syngo* CT Operator Manual Volume 6:**

syngo Colonography
syngo LungCARE CT
syngo Pulmo CT

Concept of Scan Protocols

The scan protocols for adult and children are defined according to body regions – **Head**, **Neck**, **Shoulder**, **Thorax**, **Abdomen**, **Pelvis**, **Spine**, **Upper Extremities**, **Lower Extremities**, **Vascular**, **RT**, **Specials**, and optional **Cardiac**, **PET**, **SPECT** and **Private**.

The protocols for special applications are described in the Application Guide **Clinical Applications 1** and **Clinical Applications 2** – or in the case of a Heart View examination, in the Application Guide **Heart View**.

The general concept is as follows: All protocols without suffix are standard spiral modes. E.g. "**Sinus**" means the spiral mode for the sinus.

The suffixes of the protocol name are as follows:

"**Seq**": for sequence studies

"**Routine**": for routine studies

"**Fast**": use a higher pitch for fast acquisition

"**Thin**": use a thinner slice collimation for post-processing

"**Combi**": use a thinner and a thicker slice collimation

"**UHR**": use a thin slice width for Ultra High Resolution studies and a FoV of 300 mm

"**UHRthin**": use a very thin slice width for Ultra High Resolution studies and a FoV of 300 mm

"**ECG**": use a ECG-gated or -triggered mode

"**033s**": use the rotation time of e.g. 0.33 seconds

"**Vol**": use the 3D Recon workflow

"**Neuro**": for neurologicial examinations with a special mode

A prefix of the protocol name is as follows:

"**RT**": for radio therapy studies

The availability of scan protocols depends on the system configuration.

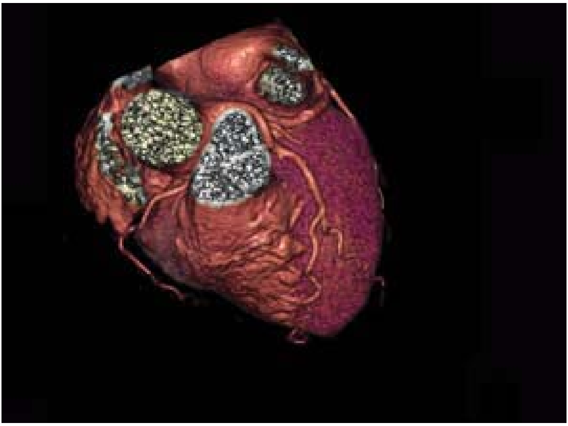
Heart Anatomy

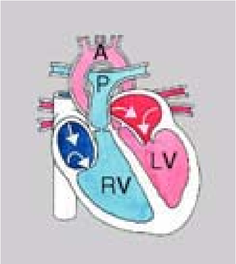
HeartView CT is a clinical application package specifically tailored to cardiovascular CT studies.

Important Anatomical Structures of the Heart

Four chambers:

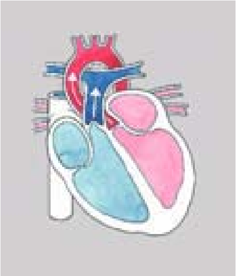
- Right atrium – receives the deoxygenated blood from the body circulation through the superior and inferior vena cava, and pumps it into the right ventricle.
- Right ventricle – receives the deoxygenated blood from the right atrium, and pumps it into the pulmonary circulation through the pulmonary arteries.
- Left atrium – receives the oxygenated blood from the pulmonary circulation through the pulmonary veins, and pumps it into the left ventricle.
- Left ventricle – receives the oxygenated blood from the left atrium, and pumps it into the body circulation through the aorta.





Blood fills both atria

Atria contract, blood enters ventricles

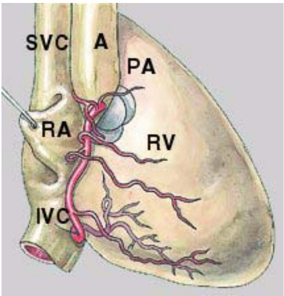


Ventricles contract, blood enters into aorta and pulmonary arteries

A: *Aorta*
P: *Pulmonary Artery*
RV: *Right Ventricle*
LV: *Left Ventricle*
RA: *Right Atrium*
LA: *Left Atrium*

Coronary arteries:

- Right coronary artery (RCA)
  Right coronary artery supplies blood to the right atrium, right ventricle, and a small part of the ventricular septum:

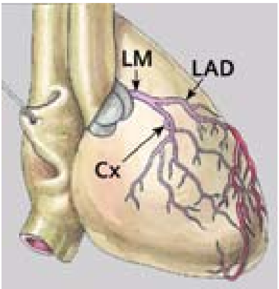


Front view

SVC:	*Superior Vena Cava*
IVC:	*Inferior Vena Cava*
RA:	*Right Atrium*
RV:	*Right Ventricle*
A:	*Aorta*
PA:	*Pulmonary Artery*

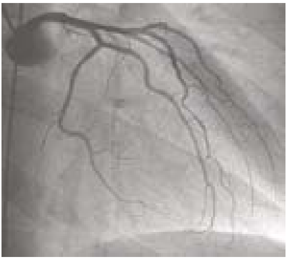
Conventional Angiography

- Left coronary artery (LCA)
  Left coronary artery supplies blood to the left atrium, left ventricle and a large part of the ventricular septum.



Front view

LM: *Left Main Artery*
LAD: *Left Anterior Descending Artery*
Cx: *Circumflex Artery*



Conventional Angiography

Placement of ECG Electrodes

The correct placement of the ECG electrodes is essential in order to receive a clear ECG signal with marked R-Waves. Incorrect placement of the electrodes will result in an unstable ECG signal which is sensitive to movements of the patient during the scan.

US Version (AHA standard)

White Electrode:

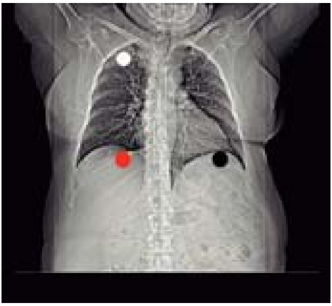
on the right mid-clavicular line, directly below the clavicle

Black Electrode:

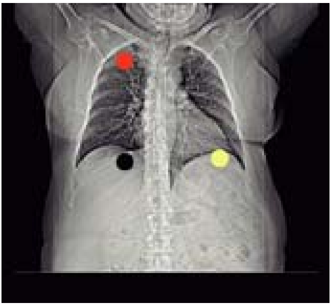
on the left mid-clavicular line, 6th or 7th intercostal space

Red Electrode:

right mid-clavicular line, 6th or 7th intercostal space



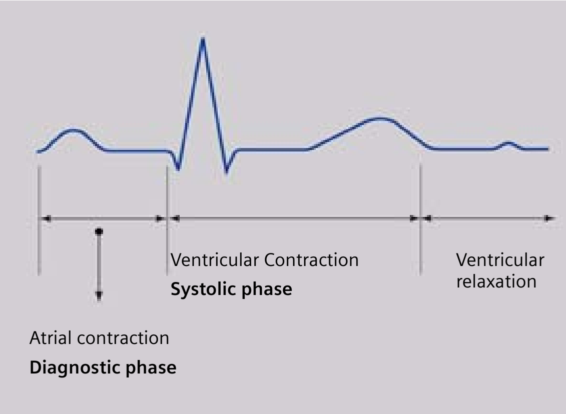
Europe Version (IEC standard)
Red Electrode
on the right mid-clavicular line, directly below the clavicle
Yellow Electrode:
on the left mid-clavicular line, 6th or 7th intercostal space
Black Electrode:
right mid-clavicular line, 6th or 7th intercostal space



Cardiac Scanning

Cardiac Cycle and ECG

The heart contracts when pumping blood and rests when receiving blood. This activity and lack of activity from a cardiac cycle can be illustrated by an Electrocardiograph (ECG).



To minimize motion artifacts in cardiac images, two requirements are mandatory for a CT system:

- Fast gantry rotation to minimize the time it takes to acquire the necessary scan data to reconstruct an image.
- Prospective triggering of image acquisition in a sequential mode or retrospective gating of image reconstruction in a spiral mode based on the ECG recording in order to obtain images during the diastolic phase when the least amount of cardiac motion occurs.

Temporal Resolution

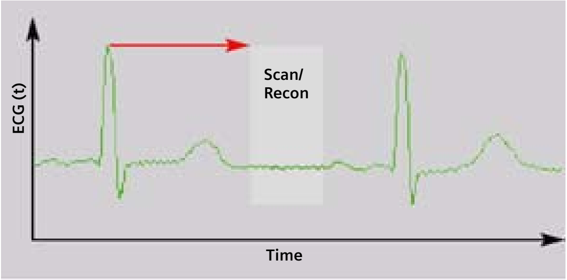
Temporal resolution, also called time resolution, represents the time window of the data that is used for image reconstruction. It is essential for cardiac CT imaging. The higher the temporal resolution, the fewer the motion artifacts. With the SOMATOM Sensation 64, for example, temporal resolution down to 83 ms (depending on the scanner) can be achieved.

Technical Principles

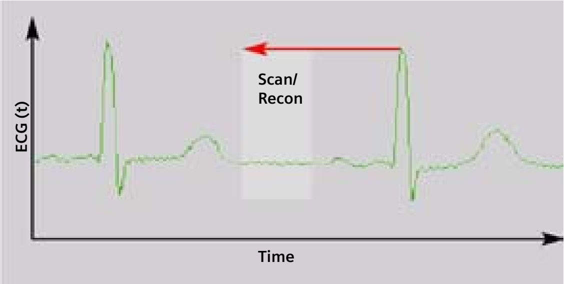
Basically, there are two different technical approaches for cardiac CT acquisition:

- Prospectively ECG-triggered sequential scanning.
- Retrospectively ECG-gated spiral scanning.

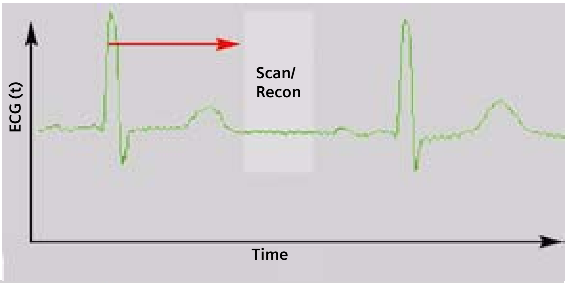
In both cases, an ECG is recorded and used to either initiate prospective image acquisition (ECG triggering), or to perform retrospective image reconstruction (ECG gating). Only scan data acquired in a user-selectable phase of the cardiac cycle is used for image reconstruction. The temporal relation of the image data interval relative to the R-waves is predefined, which can be either relative (given as a certain percentage of the RR-interval time) or absolute (given in ms) and either forward or reverse.



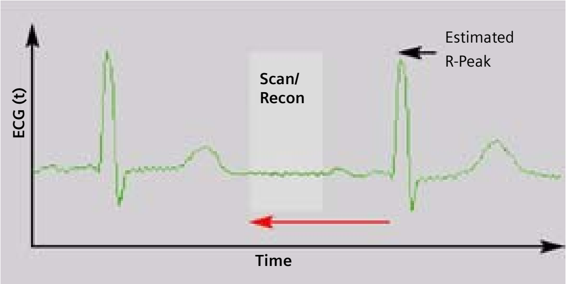
Relative – delay: a given percentage of R-R interval relative to the onset of the previous R-wave.



Relative – delay: a given percentage of R-R interval relative to the onset of the next R-wave.



Absolute – delay: a fixed time delay after the onset of the R-wave.



Absolute – reverse: a fixed time delay prior to the onset of the next R-wave.

Prospective ECG Triggering Versus Retrospective ECG Gating

With prospective ECG triggering, the heart volume is covered in a "step-and-shoot" technique. The patient's ECG signal is used to start sequential scans with a predefined offset to the R-waves of the patient's ECG. With retrospective ECG gating, the heart volume is covered continuously by a spiral scan. The patient's ECG signal is recorded simultaneously to allow a retrospective selection of the data segments used for image reconstruction. Prospective ECG triggering has the benefit of smaller patient dose than ECG-gated spiral scanning, since scan data is acquired in the previously selected heart phases only. It does not, however provide continuous volume coverage with overlapping slices and mis-registration of anatomical details may occur. Furthermore, reconstruction of images in different phases of the cardiac cycle for functional evaluation is not possible using Prospective Triggering technique. Since ECG triggered sequential scanning depends on a reliable prediction of the patient's next RR-interval by using the mean of the preceeding RR-intervals, the method should not be used for patients with arrhythmia and irregular heart rates. To maintain the benefits of ECG-gated spiral CT but reduce patient dose, ECG-controlled dose-modulation is available.

Preview Series

A Heart View preview series contains images at the same slice position and of different phases of the cardiac cycle (Phase Start). The phase interval and the number of images can be configured in the **Heart View** configuration. The slice position is determined by selecting the appropriate image in the right segment. The preview series is used to determine the Phase Start for ED and ES.

- For an overview, reconstruct a series at an arbitrary heart phase. A default value of 60% relative gating can be used as an initial set-up for the overview series.
- Select an appropriate slice position (e.g. middle part of RCA) for the preview series in the 2nd segment.
- Switch to the **Trigger** tabcard.
- Select **Phase Start 0 %** to reconstruct images in % steps.

The preview series should be used to define the optimal time window for image reconstruction in ECG-gated spiral scanning, before the full series is reconstructed.
A default value of 60% relative gating (or -400 ms absolute reverse gating) can be used as an initial set up for the optimization process which is best performed as follows:

- select an image level displaying the mid RCA.
- choose 60% (or -400 ms) reconstruction phase setting.
- reconstruct a preview series at this level of the RCA by clicking on the **Preview Series** button in the **Trigger** tabcard: a series of images with different phase settings at the selected anatomical level of the RCA will be reconstructed.
- choose the image with least motion artifacts.
- reconstruct the whole data set with the phase setting you selected. Please note that you have to enter this phase setting manually in the **Trigger** tabcard.

An example for a preview series at the correct anatomical level with optimal and sub-optimal selection of the phase setting is shown below. Usually this procedure results in good image quality for the right and the left coronary artery, especially at higher and inconsistent heart rates individual optimization for left and right coronary artery may be necessary. In most cases, the RCA requires an earlier phase in the cardiac cycle to obtain the period of least motion, e.g. RCA at 40%, LAD at 60%.

Determine ED and ES

ES: end systolic, maximum contraction of the myocardium, smallest left ventricular lumen.

ED: end diastolic, minimum contraction.

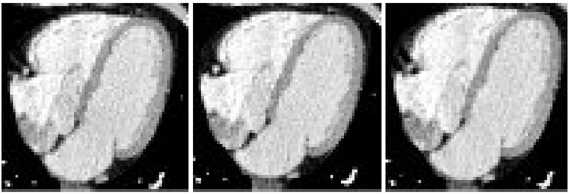
Use graphics tools (zoom & pan) to enlarge the image, switch between images to select ES and ED. It is also helpful to use the distance tool to find the images with maximum and minimum myocardial contraction. If ED or ES cannot be clearly determined because there are two adjacent images with the same contraction, use the phase in between.

Scan box

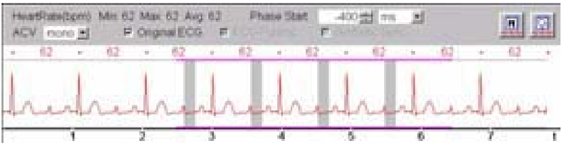
- Start the preview series reconstruction at a time point over or just before the T-wave (end ventricular systole). The settings should be sufficient to cover the cardiac cycle up to the R-wave (end ventricular diastole).
- Determine ED and ES on the Test Series ES: end systolic, maximum contraction of the myocardium, smallest left ventricular lumen. ED: end diastolic, minimum contraction. Use graphics tools (zoom & pan) to enlarge the image, switch between images to select ES and ED. It is also helpful to use the distance tool to find the images with maximum and minimum myocardial contraction. If ED or ES cannot be clearly determined because there are two adjacent images with the same contraction, use the phase in between.
- Reconstruction of two full axial image series with the time-points for ES and ED determined from the test series.
- Press **Preview Series** button.
- A preview series will be reconstructed.

Hint

- Do not enter any comments on the 2nd comment line which is reserved for labeling of the cardiac phase and heart rate in beats per minute (bpm).



Example of a preview series at the correct anatomical level (mid RCA), demonstrating the importance of optimized phase setting. Patient with an average heart rate of 63 bpm.
Left: 57%, mid: 61%, right: 65% relative delay.
The image at 61% relative delay shows the least motion artifacts. In this example, even a slight change of the phase setting from 61% to 65% deteriorates image quality.



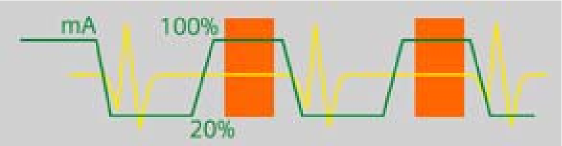
ECG Trace Editor

The ECG trace editor is used to modify the ECG signal. This editing tool is available after spiral scan data has been acquired. By using the right mouse menu on the **Trigger** tabcard you have access to several modification tools for the ECG Sync, such as **Delete, Disable, Insert**. In patients with only single or few extra-systolic beats overall image quality may be improved by editing the ECG prior to reconstruction. Deleting the corresponding R-peaks prevents image reconstruction in the extra-systolic heart periods. Please keep in mind that absolute gating (in ms) must be chosen if R-peaks are deleted. Although ECG-gated spiral scanning is less sensitive to variable heart rates than ECG-triggered sequential scanning, the examination of patients with complex arrhythmia that results in unpredictable variations of the RR-intervals (e.g. complex ventricular arrhythmia or multiple extra beats) can result in limited image quality and should be performed in exceptional cases only.

ECG Pulsing

ECG pulsing is a dedicated technique used for online dose modulation in ECG-gated spiral scanning. During the spiral scan, the output of the X-ray tube is modulated according to the patient's ECG. It is kept at its nominal value during a user-defined phase of the cardiac cycle, in general the mid to end diastolic phase.

During the resting phase of the cardiac cycle, the tube output is reduced to 20% of its nominal value. The length of the plateau with full dose is 500 ms, which is sufficient to retrospectively shift the image reconstruction interval for individual patient fine-tuning of the image reconstruction phase. When properly placed in the cardiac cycle this plateau length allows for a sufficient phase shift of the reconstruction box to cover both end-systolic and diastolic reconstructions. The tube current is reduced and not switched off to allow for image reconstruction throughout the entire cardiac cycle. Even though their signal-to-noise ratio is decreased, the low-dose images are sufficient for functional evaluation. Clinical studies have demonstrated dose reduction of up to 50% depending on the patient's heart rate using ECG pulsing. **ECG pulsing** can be switched on/off by you on the **Trigger** tabcard. When using ECG pulsing, the desired reconstruction phase has to be estimated and entered into the **Trigger** tabcard prior to scanning, since it determines the time interval of maximum dose. ECG pulsing should not be used for patients with irregular heart rates and arrhythmia.



Dose modulation with ECG pulsing

The width of the ECG pulsing window depends on the rotation time.

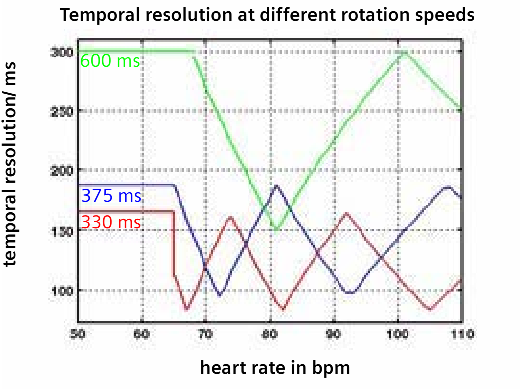
Rotation time	ECG pulsing
0.5 s/ 500 ms	450 ms
0.6 s/ 600 ms	460 ms
0.37 s/ 370 ms	360 ms
0.33 s/ 330 ms	330 ms

ACV on/off

On the **Trigger** tabcard, **ACV** (Adaptive Cardio Volume reconstruction) can be switched on/off by you. With ACV off, single segment reconstruction is performed for all heart rates. Data acquired in one heart cycle is used for the reconstruction of each image, and the temporal resolution is independent of the heart rate.

Example: The temporal resolution is 165 ms for 0.33 s gantry rotation time. With ACV on, the system automatically switches between single segment and two segment reconstruction depending on the patient's heart rate. For heart rates below 62 bpm at 0.33 s gantry rotation time, single segment reconstruction is performed. For heart rates exceeding 62 bpm, two segment reconstruction is performed, using scan data acquired in two subsequent heart cycles to improve temporal resolution. With ACV on, temporal resolution is constant for heart rates below 62 bpm (165 ms for 0.33 s gantry rotation time). For heart rates above 62 bpm, temporal resolution varies between 82 ms and 165 ms depending on the patient's heart rate, reaching its optimum (82 ms) at 68, 82 or 105 bpm.

Temporal resolution as a function of the patient's heart rate is shown in the figure below. We recommend switching **ACV** on.

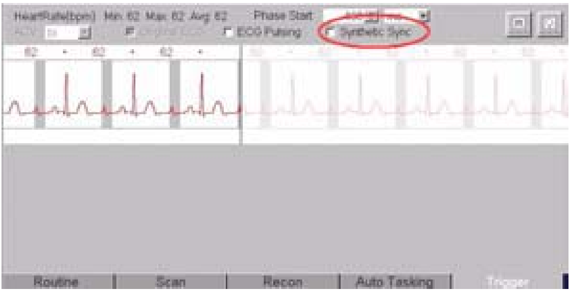


Temporal resolution as a function of the patient's heart rate for 0.6s, 0.37s and 0.33s gantry rotation time.

Synthetic Trigger

By default, the **Synthetic Trigger** (ECG-triggered scanning) or **Synthetic Sync** (ECG-gated scanning) is activated for all predefined cardiac scan protocols. It is recommended to always keep it activated for examinations with contrast medium.

In case of ECG signal loss during the acquisition, this will ensure the continuation of the triggered scans or allows an ECG to be simulated for retrospective gating. If it is deactivated, the scanning will be aborted in case of ECG signal loss during the acquisition.



Cardiac Reconstruction

Axial Images

Reconstruction of axial images during the examination are used for filming/archiving and for post-processing.

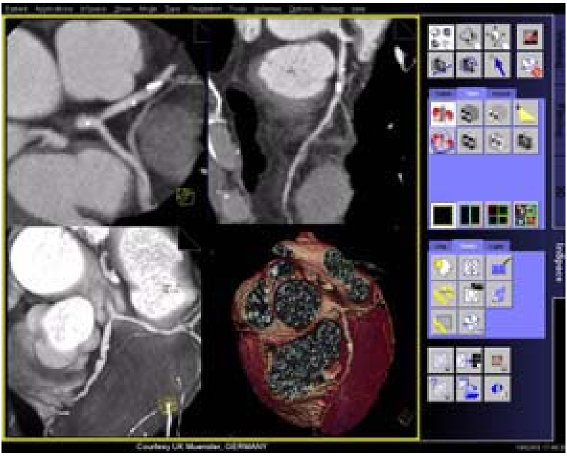
A. Filming and Archiving
Use a thicker slice thickness and recon increment for filming and archiving of the images, e.g. 3 mm slice thickness and 3 mm increment, to produce less images.
You can send this recon job via the **Auto Tasking** tab-card directly to the filmsheet or archiving node.

B. Calcium Scoring Postprocessing
Use a thicker slice thickness and a smaller recon increment to load the images afterwards in the application ***syngo* Calcium Scoring**, e.g. 3 mm slice thickness and 1.5 mm increment.

C. 3D Postprocessing
Use a thinner slice thickness and recon increment for post-processing of the images, e.g. 0,6 mm slice thickness and 0.4 mm increment. These images are used for post-processing on the **3D** card or with ***syngo* InSpace4D**.

You can select different image types, e.g. MIP or VRT to get the best view of the coronary arteries.

3D card



syngo InSpace

Double-Oblique Images

Reconstruction of double-oblique images are used for post-processing.

If you want to use short axis images of the heart, there are different possibilities to create them:

- During scanning
  You can reconstruct short axis spiral oblique (SPO) images in different heart phases directly during the examination.

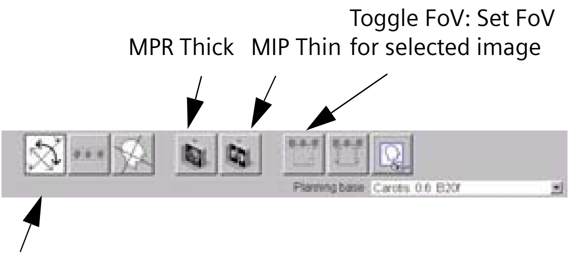
- After scanning

1. If you have saved the raw data of the Cardio scan: You can reconstruct short axis spiral oblique (SPO) images in different heart phases by loading the raw data in the **Examination** card of your Navigator, or you can also load the raw data in the reconstruction card of your Wizard (optional) console.
2. After reconstruction of different axial heart phases, you can reconstruct short axis MPR images on the **3D** card.

Short Axis Images

Short axis reconstruction on the **Examination** *or* **Recon** *card:*

Select
- **Recon axis – oblique**
- **Image type – spiral oblique (SPO)**
- **Enable Button – FreeMode**



FreeMode:
- *Off: You can navigate through the volume by moving the reference lines.*
  The FoV does not move.
- *On: The reference lines can be rotated to obtain oblique/double-oblique views.*

Select the coronal view, rotate the sagittal line to the level of the heart valve and the sulcus.

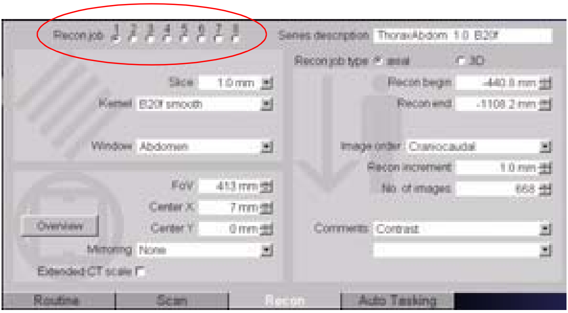
Number of images = 10

Distance between images = 8 mm

Slice Thickness = 8 mm

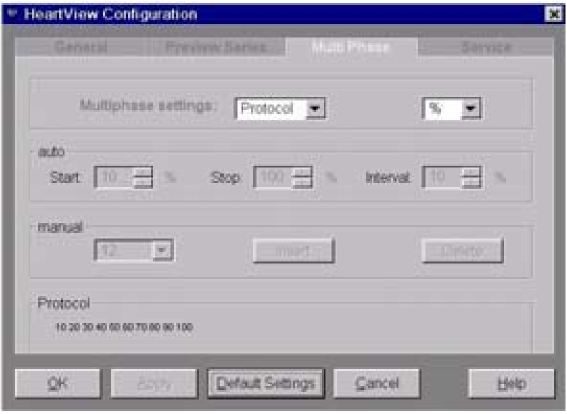
Multiphase Reconstruction

Select a new recon job on the **Recon** card:



Select the **Multiphase** button on the **Trigger** tabcard.

With a right mouse click on the **Multiphase** button you can open the **Heart View Configuration** window.


HeartView Configuration
General
Preview Series
Multi Phase
Service
Multiphase settings:
Protocol
%
auto
Start:
10
%
Stop:
100
%
Interval:
10
%
manual
12
Insert
Delete
Protocol
10 20 30 40 50 60 70 80 90 100
OK
Apply
Default Settings
Cancel
Help

Three different **Multiphase settings** are possible:

1. **Protocol**
   displays the settings for the selected scan protocol.
2. **Auto**
   You can define the heart phase settings with a regular interval in between, e.g. for an Argus movie.
3. **Manual**
   You can define the irregular heart phase settings with an interval, e.g. to calculate the ejection fraction.

All choices are available for % or ms.

Reconstruction Examples

1. *Reconstruction of the whole cardiac cycle, e.g. to create a movie in syngo ARGUS:*

Select **Multiphase** settings: **Auto** and choose % values.

Enter "10" as **Start** and "100" as **Stop**.
Select "10" as **Interval**.

As result you will get 10 series with the heart phases: **10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%**.

2. *Reconstruction of irregular heart phases, e.g. for the ejection fraction:*

Select **Multiphase** settings: **Manual** and choose % values.

Enter "20" for the reconstruction of the ES (maximum left ventricular lumen) and "80" for the reconstruction of the ED (minimum left ventricular lumen).

As result you will get 2 series with the heart phases: **20%** and **80%**.

3. *Reconstruction of irregular heart phases, e.g. for the best display of the coronary arteries:*

***LAO*:**

Select **Multiphase** settings: **Manual** and choose % values.

Enter "50" "52" "55" "58" "60" to find out the best display of the LAO view.

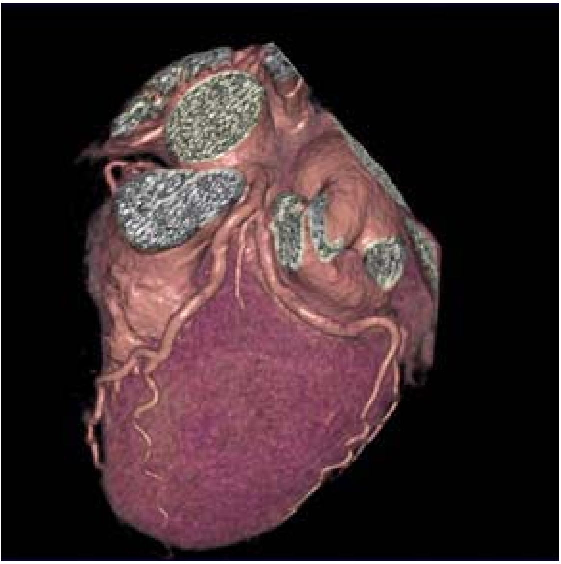
As result you will get 5 series with the heart phases: 50%, 52%, 55%, 58%, 60%.

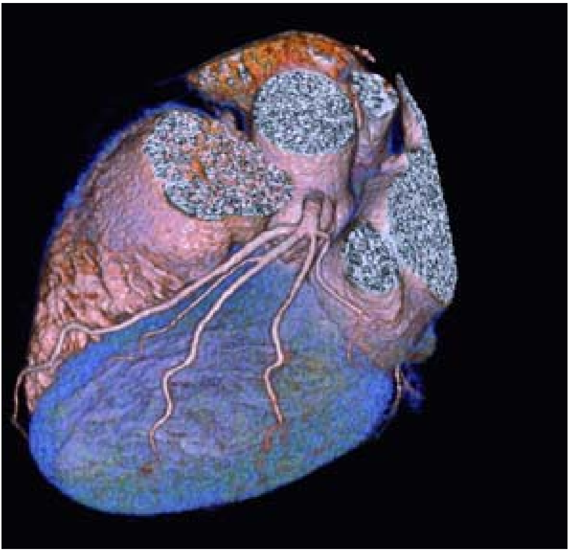
If you want to create your own multiphase recon job in a cardio scan protocol:

Define either an auto or a manual setting, than select the **Multiphase settings – Protocol**. Press button **Apply**, close the window with **OK**. Then you can save the scan protocol as usual and the selected recon job will always be reconstructed using a multiphase.

Hints:

- To get a constant image quality for the Multiphase reconstruction we recommend turning ECG pulsing **OFF**.
- If you are not sure which heart phases are the best one for the Multiphase reconstruction, perform a preview series first.
- Press **Recon** button for each 3D reconstruction.



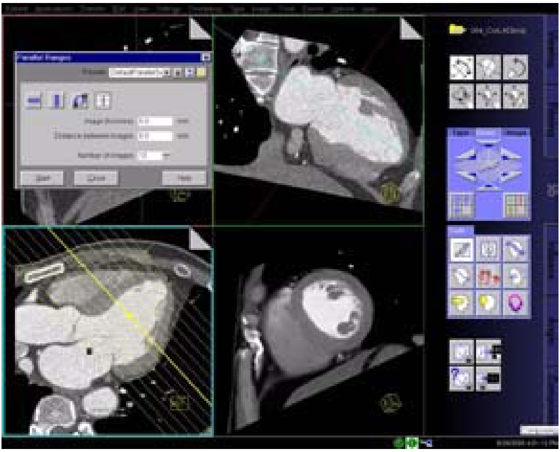


Cardiac Postprocessing on the 3D Card

Reconstruction of the Short Heart Axis

- Load the first (ED) series into **3D** card
- Adjust the reference plane to obtain short-axis views of the heart
- Press button for **parallel ranges**

Recommended parameters:
Image thickness: 8 mm
Distance between images: 8 mm
Number of images: ~13 (adjust to cover ventricles)



- You must save this MPR range as a preset (Short-axis) for subsequent reformatting of other time series.
- You may link one preset to the series description. By doing this, the preset will be applied automatically when the next series is loaded into **MPR Ranges**.
- Save the MPR series with a sensible description such as Short Axis, 25%.
- Repeat the procedure with the next series.

Hint: Do not change any parameters for the MPR ranges. Otherwise, ***syngo*** **Argus** is not able to sort the images correctly.

Auto Load in 3D and Postprocessing Presets

You can activate the **Auto load in 3D** function on the **Examination** card/**Auto Tasking** and link it to a recon job, e.g. the 2nd recon job with thinner slice width in some of the examination protocols. If the post-processing type is chosen from the pull down menu, the reconstructed images will be loaded automatically into the **3D** card on the Navigator with the corresponding postprocessing type.

On the **3D** card you have the ability to create Range Parallel and Radial protocols for Multi-Planar-Reconstruction (MPR) and Thin Maximum-Intensity-Projection (MIP Thin), which can be linked to a special series.

For example, if you always do sagittal Multiplanar reconstructions for a Spine examination, once you load a Spine examination into the **3D** card, select the image type (MPR, MIP Thin), select the orientation and open the **Range Parallel** function. Adapt the range settings (**image thickness, distance between the images** etc.) and hit the link button. From that point on, you have a predefined postprocessing protocol, linked to the series description of a Spine examination.

The same can be done for VRT presets. In the main menu, under **Type/VRT Definition**, you can link VRT presets with a series description.

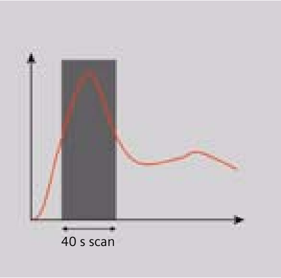
Some of the scan protocols, primarily for Angio examinations, are already preset in the protocol with **Auto load in 3D**. If you prefer not to use this preset, deselect the **Auto load in 3D** and save your scan protocol.

Some of the scan protocols are preset in the protocol with links to a postprocessing protocol. If you prefer not to use this preset, please delete the **Range Parallel** preset or overwrite them with your own settings.

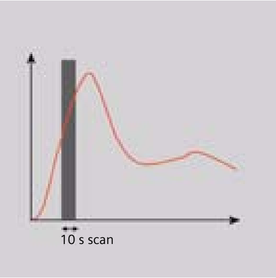
Contrast Medium

The Basics

The administration of intravenous (IV) contrast material during spiral scanning improves the tissue characterization and characterization of lesions, as well as the opacity of vessels. The contrast scan will yield good results only if the acquisition occurs during the optimal phase of enhancement in the region of interest. Therefore, it is essential to initiate the acquisition with the correct start delay. Since multislice spiral CT can provide much faster speed and shorter acquisition time, it is even more critical to get the right timing to achieve optimal results.



Longer scan time



Shorter scan time

The dynamics of the contrast enhancement is determined by:

- Patient cardiac output
- Injection rate (Fig. A, B)
- Total volume of contrast medium injected (Fig. C, D)
- Concentration of the contrast medium (Fig. D, E)
- Type of injection – uni-phasic or bi-phasic (Fig. E, F)
- Patient pathology

Aortic time-enhancement curves after i.v. contrast injection (computer simulation*).

All curves are based on the same patient parameters (male, 60-year-old, 75 kg).

** Radiology 1998; 207:647-655*

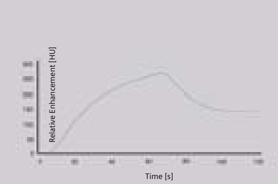


*Fig. A: 2 ml/s,
120 ml, 300 mg I/ml*

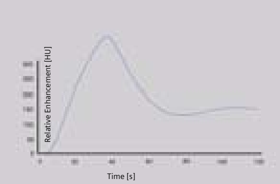


*Fig. B: 4 ml/s,
120 ml, 300 mg I/ml*

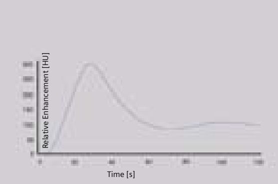


*Fig. C: 80 ml,
4 ml/s, 300 mg I/ml*

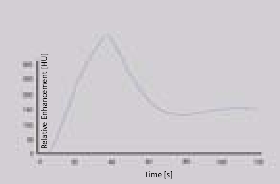


*Fig. D: 120 ml,
4 ml/s, 300 mg I/ml*

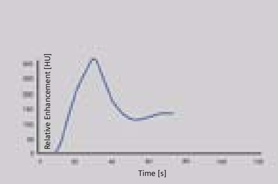


*Fig. E: Uni-phase
140 ml, 4 ml/s,
370 mg I/ml*

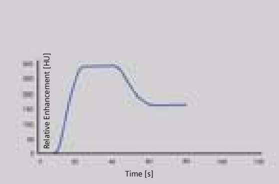


*Fig. F: Bi-phase
70 ml, 4 ml/s,
plus 70 ml,
2 ml/s, 370 mg I/ml*

IV Injection[1]

The administration of a contrast medium depends on the indication and on the delay times to be used during the examination. The patients weight and circulatory situation also play a role. In general, no more than 3 ml per kg of body weight for adults and 2 ml per kg of body weight for children should be applied.

For a CTA study (arterial phase), the principle is to keep the contrast flowing throughout the duration of the scan. Thus, the total amount of contrast medium needed should be calculated with the following formula:

CM = (start delay time + scan time) x flow rate.

CARE Bolus or Test bolus may be used for optimal contrast bolus timing. Please refer to the special protocols.

To achieve optimal results in contrast studies, the use of CARE Bolus is recommended. In a case where it is not available, use Test Bolus. Once completed, load images into **Dynamic Evaluation** for calculation of **Time to Peak** enhancement.

For multiphase examinations, e.g. three-phase liver, the maximum start delay can be set to 600 sec. The countdown of the delay always starts after scanning of the previous phase.

1 *For more information regarding the general use of drugs and doses mentioned in this guide please refer to page 2.*

Bolus Tracking

This is an automatic Bolus Tracking program, which enables triggering of the spiral scanning at the optimal phase of the contrast enhancement.

Additional Important Information

1. This mode can be applied in combination with any spiral scanning protocol. Simply insert **Bolus Tracking** by clicking the right mouse button in the chronicle. This inserts the entire set up including pre-monitoring, i.v. bolus and monitoring scan protocol. You can also save the entire set up within your own scan protocols.
2. The pre-monitoring scan is used to determine the position of the monitoring scans. It can be performed at any position of interest. You can also increase the mAs setting to reduce the image noise when necessary.
3. To achieve the shortest possible spiral start delay (2 s), the position of the monitoring scans relative to the beginning of spiral scan must be optimized.
   A **snapping** function is provided:

– After the Topogram is performed, the predefined spiral scanning range and the optimal monitoring position will be shown.
– If you need to redefine the spiral scanning range, you should also reposition the monitoring scan in order to keep the shortest start delay time (2 s). (The distance between the beginning of the spiral scanning range and the monitoring scan will be the same).
– Move the monitoring scan line *towards* the optimal position and release the mouse button, it will be snapped automatically. (Trick: if you move the monitoring scan line *away* from the optimal position the **snapping** mechanism will be inactive).

4. Place a **ROI** in the premonitoring scan on the target area or vessel used for triggering with one left mouse click. (The ROI is defined with double circles – the outer circle is used for easy positioning, and the inner circle is used for the actual evaluation). You can also zoom the reference image for easier positioning of the ROI.
5. Set the appropriate trigger threshold, and start contrast injection and monitoring scans at the same time.
   During the monitoring scans, there will be simultaneous display of the relative enhancement of the target ROI. When the predefined density is reached, the spiral acquisition will be triggered automatically.
6. You can also initiate the spiral any time during the monitoring phase manually – either by pressing the **START** button or by left mouse clicking the **START radio** button. If you do not want to use automatic triggering, you can set your trigger threshold number extremely high so that it will not trigger automatically, and you can start the spiral when you desire.

Test Bolus using CARE Bolus

You can use the CARE Bolus option as a **Test Bolus**.

How to do it

1. Insert a Bolus tracking via the right mouse button submenu prior to the spiral.
2. Insert **contrast** from the right mouse button context menu.
   Hint: By inserting **contrast** you are interrupting the **Auto range function**, and therefore an automatic start of the spiral is not possible!
3. Start with the Topogram.
4. Position the premonitoring scan and the spiral.
5. Perform the premonitoring scan, position and accept the ROI.
6. Start the monitoring scans and a small amount of contrast (20 ml/2.5 ml/sec.).
   Hint: With starting the spiral, the system switches to the **Trigger** tabcard. The trigger line is not shown at this stage.
7. Now you can read the proper delay from the trigger card.
8. Insert the delay in the **Routine** tabcard and load the spiral.
9. Start spiral and injector with the full amount of contrast.

Test Bolus

This is a low dose sequential protocol without table feed used to calculate the start delay of a spiral scan to ensure optimal enhancement after the contrast medium injection. The **Dynamic Evaluation** function may be used to generate the time density curve. You can find the **Test Bolus** scan protocol in the chapter **Specials**.

How to do it

1. Select the spiral mode that you want to perform, and then **Append** the TestBolus mode under **Special** protocols.
2. Insert the Test bolus mode above the spiral mode for contrast scan by **cut/paste** (with right mouse button).
3. Perform the Topogram, and define the slice position for Test bolus.
4. Check the start delay, number of scans and cycle time before loading the mode.
5. A Test bolus with 10 – 20 ml is then administered with the same flow rate as during the subsequent spiral scan. Start the contrast media injection and the scan at the same time.
6. Load the images into the **Dynamic Evaluation** function and determine the time to the peak enhancement. Alternatively, on the image segment, click **select series** with the right mouse button and position an ROI on the first image. This ROI will appear on all images in the test bolus series. Find the image with the peak HU value, and calculate the time **delta t** taken to reach the peak HU value (do not forget to add the preset start delay time). This time can then be used as the optimal start delay time for the spiral scan.

CARE Contrast

With the injector coupling, the bolus injector can now be connected to your CT scanner.

Key features

- Synchronized scanning and contrast injection
- One button control from the CT-console and from the injector
  - The scan start can be initiated by the injector and also by the CT scanner, without having to press both start buttons at the same time.
  - The start by the CT can also be done via the foot switch.
  - The start of the CT scanner, including the start delay can be initiated also by the start button at the bolus injector.

The injector and the CT have to be coupled explicitly. You can store protocols where the injector coupling is selected.

Workflow

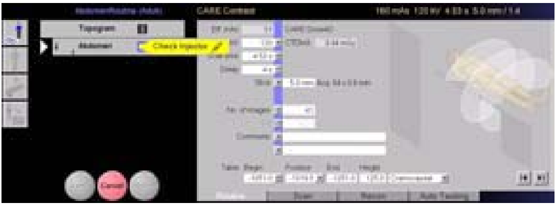
To start a contrast enhanced examination in coupled mode:

- Select the **Scan** subtask card.
- Select under the menu field **Scan Start** either the entry **Injector coupled (Start button)** or the entry **Injector coupled (Footswitch)**.
  - Injector coupled (Start button): The **Start** button of the CT scanner will start the injector.
  - Injector coupled (Footswitch): The footswitch of the CT scanner will start the injector.

If an injector is connected, load the scan mode first and then arm the injector.

Depending on the injector it might be not possible to arm the injector before the scan protocol is loaded (see User manual of the injector). When the mode is loaded, the CT scanner will ask you to check the injector and to arm it. Check the parameters at the injector side and confirm the parameters. The injector is armed and ready for the examination.

Note: If the scan mode is unloaded the injector will also be disabled.



After the Injector is armed the scan and the injector can be started, by pressing either the **Start** button/ Footswitch at the scanner, or the **Start** button at the injector panel outside of the scan room or directly at the injector inside the scan room.

Note: If the Injector is not ready the scan can not be started. If both systems are ready to START and the user disarms the injector, the bubble **Check Injector** is shown again.

Additional Important Information

- If **Coupled Mode** is selected the CT checks if there is an injector available.
  The scan mode cannot be loaded if a connection cannot be established or if the injector does not accept coupling (The injector will not accept coupling while injecting).
  A message appears: Injector is not connected.
- Scanning interrupted
  If the injector does not accept the START from the CT the scan mode is cancelled.
  If the scanner is suspended by the user or due to technical problems the injector will be stopped too.
- Injector stopped
  If the injector is stopped by the user the scan will be stopped too.
  If the injector is interrupted by pressing the **Hold** button the scan will be continued.
- The injector reports a technical problem:
  The connection between scanner and injector is interrupted, or the injection was stopped due to technical problems. In this case the scan continues and an error message pops up.
  The user can decide if he wants to stop the scan or if he would like to continue.

- If the injection is longer than the CT scan, the CT scanner does not stop the injection.
  A new scan mode can be loaded. If the new mode is a coupled mode, the scan can only be started if the injector is ready.
- When a coupled range is pasted or repeated, the start condition for the new scan is reset to uncoupled.

Contrast Medium

Scanning

This application is used for identification and quantification of calcified lesions in the coronary arteries.
It can be performed with both Prospective ECG triggering (sequential scanning) and Retrospective gating (spiral scanning) techniques. The following scan protocols are predefined:

SOMATOM Sensation 64:

- **CaScore033s**
  - Spiral Protocol using a rotation time of 0.33 s
- **CaScore037s**
  - Spiral Protocol using a rotation time of 0.37 s
- **CaScoreSeq**
  - Sequential scan protocol with ECG triggering

SOMATOM Sensation 40:

- **CaScore037s**
  - Spiral Protocol using a rotation time of 0.37 s
- **CaScoreSeq**
  - Sequential scan protocol with ECG triggering

SOMATOM Sensation Open:

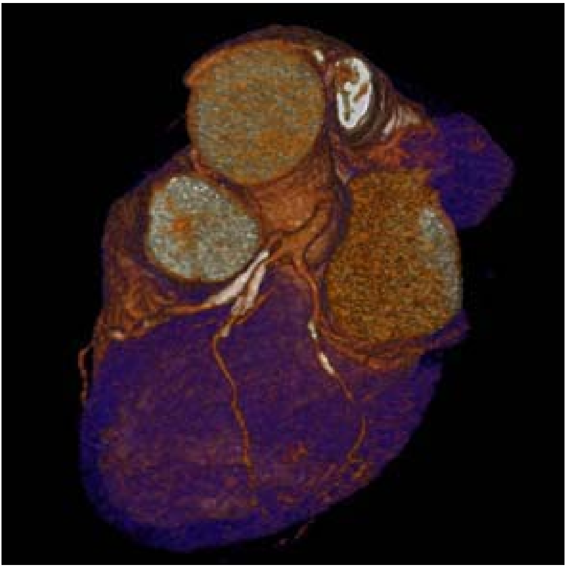
- **CaScore**
  - Spiral Protocol using a rotation time of 0.5 s
- **CaScoreSeq**
  - Sequential scan protocol with ECG triggering

SOMATOM Emotion 6:

- **CaScore06s**
  - Spiral Protocol using a rotation time of 0.6 s
- **CaScoreSeq06s**
  - Sequential scan protocol with ECG triggering using a rotation time of 0.6 s

- **CaScoreSeq**
  - Sequential scan protocol with ECG triggering

SOMATOM Emotion Duo:
- **CaScoreSeq**
  - Sequential scan protocol with ECG triggering



Hints in General

- Kernel B35f is dedicated to calcium scoring studies, providing the most accurate determination of the HU-value of small calcified lesions. To ensure the optimal image quality and correlation to known reference data, other kernels are not recommended.
- Use the ECG-triggered protocol for low-dose scanning except for patients with arrhythmia. Use the ECG-gated protocol when accuracy and/or reproducibility are essential, e.g. for follow-up studies of calcium scoring.

CaScore033s

Indications:

This is a spiral scanning protocol, using an ECG gating technique and a rotation time of 0.33 s for coronary calcium scoring studies.

A typical scan range of 15 cm will be covered in 9.25 sec.

Topogram:
AP, 512 mm.
From the carina to the apex of the heart.

Sensation 64	**CaSc**
kV	*120*
Effective mAs/ Quality ref. mAs	*190*
Rotation Time	*0.33 sec.*
Acquisition	*24 x 1.2 mm*
Slice collimation	*1.2 mm*
Slice width	*3.0 mm*
Feed/Rotation	*5.8 mm*
Pitch Factor	*0.20*
Increment	*1.5 mm*
Kernel	*B35f*
*Temp. resolution**	*up to 83 ms*
$CTDI_{Vol}$	*12.7 mGy*
Effective dose	*Male: 4.07 mSv* *Female: 5.37 mSv*

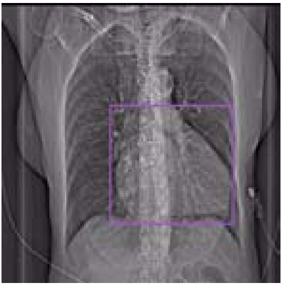
** depends on heart rate*

CaScore037s

Indications:

This is a spiral scanning protocol, using an ECG gating technique and a rotation time of 0.37 s for coronary calcium scoring studies.

A typical scan range of 15 cm will be covered in 8.89 sec.



Topogram:
AP, 512 mm.
From the carina to the apex of the heart.

Sensation 64	**CaSc**
kV	*120*
Effective mAs/ Quality ref. mAs	*170*
Rotation Time	*0.375 sec.*
Acquisition	*24 x 1.2 mm*
Slice collimation	*1.2 mm*
Slice width	*3.0 mm*
Feed/Rotation	*6.9 mm*
Pitch Factor	*0.24*
Increment	*1.5 mm*
Kernel	*B35f*
*Temp. resolution**	*up to 94 ms*
$CTDI_{Vol}$	*11.4 mGy*
Effective dose	*Male: 3.64 mSv* *Female: 4.80 mSv*

** depends on heart rate*

Sensation 40	**CaSc**
kV	*120*
Effective mAs/ Quality ref. mAs	*170*
Rotation Time	*0.375 sec.*
Acquisition	*24 x 1.2 mm*
Slice collimation	*1.2 mm*
Slice width	*3.0 mm*
Feed/Rotation	*6.9 mm*
Pitch Factor	*0.24*
Increment	*1.5 mm*
Kernel	*B35f*
*Temp. resolution**	*up to 94 ms*
$CTDI_{Vol}$	*11.4 mGy*
Effective dose	*Male: 3.47 mSv* *Female: 4.65 mSv*

** depends on heart rate*

CaScore

Indications:

This is a spiral scanning protocol, using an ECG gating technique for coronary calcium scoring studies.

A typical scan range of 15 cm will be covered in 8.89 sec.

Topogram:
AP, 512 mm.
From the carina to the apex of the heart.

Sensation Open	**CaSc**
kV	*120*
Effective mAs/ Quality ref. mAs	*150*
Rotation Time	*0.50 sec.*
Acquisition	*24 x 1.2 mm*
Slice collimation	*1.2 mm*
Slice width	*3.0 mm*
Feed/Rotation	*9.5 mm*
Pitch Factor	*0.33*
Increment	*1.5 mm*
Kernel	*B35f*
*Temp. resolution**	*up to 125 ms*
$CTDI_{Vol}$	*13.5 mGy*
Effective dose	*Male: 4.68 mSv* *Female: 5.87 mSv*

** depends on heart rate*

CaScore06s

Indications:

This is a spiral scanning protocol, using an ECG gating technique and a rotation time of 0.6 s for coronary calcium scoring studies.

A typical scan range of 12.25 cm will be covered in 16.51 sec.

Topogram:
AP, 512 mm.
From the carina to the apex of the heart.

Emotion 6	CaScore
kV	*130*
Effective mAs/ Quality ref. mAs	*75*
Rotation Time	*0.6 sec.*
Acquisition	*6 x 2.0 mm*
Slice collimation	*2.0 mm*
Slice width	*3.0 mm*
Feed/Rotation	*4.8 mm*
Pitch Factor	*0.40*
Increment	*2.5 mm*
Kernel	*B35s*
*Temp. resolution**	*up to 150 ms*
$CTDI_{Vol}$	*8.51 mGy*
Effective dose	*Male: 1.80 mSv* *Female: 2.53 mSv*

** depends on heart rate*

CaScoreSeq

Indications:

This is a sequential scanning protocol with ECG triggering for coronary calcium scoring studies.

For SOMATOM Sensation 64:
The scan length is 15.9 cm.

For SOMATOM Sensation 40 and Sensation Open:
The scan length is 15.3 cm.

*Topogram:
AP, 512 mm.
From the carina to the apex of the heart.*

Sensation 64	**CaScSeq**
kV	*120*
mAs/ Quality ref. mAs	*40*
Rotation Time	*0.33 sec.*
Acquisition	*30 x 0.6 mm*
Slice collimation	*0.6 mm*
Slice width	*3.0 mm*
Feed/Scan	*18.0 mm*
Kernel	*B35f*
*Temp. resolution**	*up to 165 ms*
$CTDI_{Vol}$	*2.9 mGy*
Effective dose	*Male: 0.56 mSv Female: 0.77 mSv*

** depends on heart rate*

Sensation 40	CaScSeq
kV	*120*
mAs/ Quality ref. mAs	*40*
Rotation Time	*0.37 sec.*
Acquisition	*20 x 0.6 mm*
Slice collimation	*0.6 mm*
Slice width	*3.0 mm*
Feed/Scan	*12.0 mm*
Kernel	*B35f*
*Temp. resolution**	*up to 165 ms*
$CTDI_{Vol}$	*3.3 mGy*
Effective dose	*Male: 0.62 mSv Female: 0.85 mSv*

** depends on heart rate*

Sensation Open	CaScSeq
kV	*120*
mAs/ Quality ref. mAs	*30*
Rotation Time	*0.50 sec.*
Acquisition	*20 x 0.6 mm*
Slice collimation	*0.6 mm*
Slice width	*3.0 mm*
Feed/Scan	*12.0 mm*
Kernel	*B35s*
*Temp. resolution**	*up to 250 ms*
$CTDI_{Vol}$	*3.3 mGy*
Effective dose	*Male: 0.80 mSv Female: 1.05 mSv*

** depends on heart rate*

For SOMATOM Emotion 6:
The scan length is 12.3 cm.

For SOMATOM Emotion Duo:
The scan length is 12.25 cm.

Emotion 6	**CaScoreSeq**
kV	*130*
mAs/ Quality ref. mAs	*30*
Rotation Time	*0.80 sec.*
Acquisition	*6 x 3.0 mm*
Slice collimation	*3.0 mm*
Slice width	*3.0 mm*
Feed/Scan	*18.0 mm*
Kernel	*B35s*
*Temp. resolution**	*up to 400 ms*
$CTDI_{Vol}$	*3.19 mGy*
Effective dose	*Male: 1.02 mSv Female: 1.44 mSv*

** depends on heart rate*

Emotion Duo	**CaScoreSeq**
kV	*130*
mAs/ Quality ref. mAs	*30*
Rotation Time	*0.80 sec.*
Acquisition	*2 x 2.5 mm*
Slice collimation	*2.5 mm*
Slice width	*2.5 mm*
Feed/Scan	*5.0 mm*
Kernel	*B35s*
*Temp. resolution**	*up to 400 ms*
$CTDI_{Vol}$	*3.2 mGy*
Effective dose	*Male: 0.63 mSv Female: 0.91 mSv*

** depends on heart rate*

If you apply API for image acquisition, please make sure that the breathhold interval in the **Patient Model Dialog** is longer than the total scan time, e.g. 50 sec., otherwise the image acquisition will be interrupted by the default breathhold interval. This does not apply when API is not activated.

CaScoreSeq06s

Indications:

This is a sequential scanning protocol with ECG triggering for coronary calcium scoring studies.

The scan length is 12.3 cm.

Topogram:
AP, 512 mm.
From the carina to the apex of the heart.

Emotion 6	**CaScoreSeq**
kV	*130*
mAs/ Quality ref. mAs	*30*
Rotation Time	*0.6 sec.*
Acquisition	*6 x 3.0 mm*
Slice collimation	*3.0 mm*
Slice width	*3.0 mm*
Feed/Scan	*18.0 mm*
Kernel	*B35s*
*Temp. resolution**	*up to 300 ms*
$CTDI_{Vol}$	*3.19 mGy*
Effective dose	*Male: 1.02 mSv Female: 1.44 mSv*

** depends on heart rate*

Postprocessing

***syngo* Calcium Scoring** is an evaluation software used for quantification of calcified coronary lesions.
The data is based on a low dose acquisition with either an ECG-triggered Sequence or a retrospectively gated Spiral.

- Evaluation on a separate ***syngo*** task card on the user interface.
- Scoring is facilitated with selection and automatic growing tools for definition of lesions in the main coronary branches (RCA, LM, LAD, CX).
- Freehand ROI definition of lesions in addition to the seeding method.
- 3D Edit for separation and modification of lesions within a defined volume (depth in mm), and on 2D-slices possible.
- Correlated image display in different planes using Maximum Intensity Projection (MIP) and Multi Planar Reformats (MPR).
- Blow-up display for easier identification of small lesions.
- Default threshold of 130 HU for score calculation can be modified.
- Online display of results in a separate segment:
  - Interpolated Volume (in mm^3).
  - Calcium mass (mg Calcium Hydroxyapatite).
  - Score (Agatston method).

- Generation of HTML report including site specific information, free text and clinical images, and saving on floppy disk and/or printing.
- Interface to user-defined reference table can be used for risk stratification and the corresponding risk percentile information can be included in the report.
- Printing of results on laser film, paper printer or saving into database.

Prerequisites

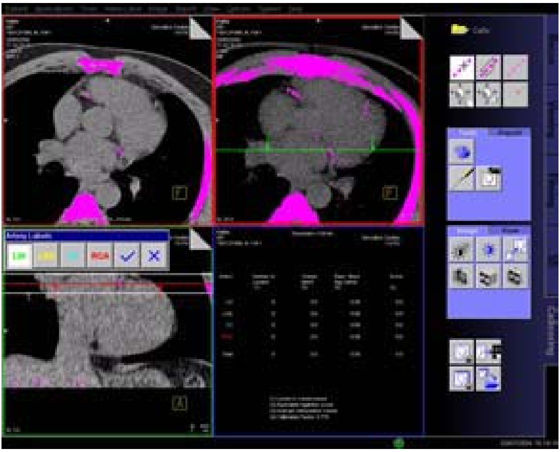
To achieve standardization of the evaluation results the image material must meet the following requirements:

- Only images of one patient must be loaded for ***syngo* Calcium Scoring** evaluation.
- The scans must have been acquired without gantry tilt (gantry tilt = 0).
- Only original image material must be used that has neither been edited with 2D tools in the **Viewing** task card e.g., Zoom&Pan nor with 3D tools in 3D e.g., curved mode.
- Only image data sets with the same slice orientation must be used.
- Only contiguously scanned and reconstructed sequence or spiral data sets with identical slice distances and identical thickness must be evaluated.
- The slices must have been scanned at different table positions.
- The data capacity of the volume must not exceed 1024 images with a matrix size of 512 x 512 pixels.
- Only studies without contrast medium must be used.

General Workflow

1. Loading the Images

After loading the images into Calcium Scoring the following layout is displayed:



The loaded images are displayed in the following projection modes:

1. *Tomo segment*:
   Current slice in transaxial projection (caudo-cranial direction)
2. *Overview segment*:
   Sliding MIP mode in caudo-cranial projection (can be changed to MIP or MPR, but will always be the reconstructed volume in transaxial projection – entire calcium detection)
3. *Detail segment*:
   MPR mode in coronal projection (can be changed to MIP or MIP Thin and from coronal to sagittal)
4. *Result segment*

2. Evaluating Coronary Lesions

- Screening loaded images for coronary lesions with significantly increased calcification.
- Marking the detected lesions in the tomogram.
- Editing the coronary lesions in 3D or 2D.

2.1. Screening

After loading the CT images, you can

- scroll through
- zoom
- change window for better display.

In the images of your Calcium Scoring examination all structures with calcium values above the set threshold value are displayed in color.

Before you start to identify coronary arteries and specific coronary lesions you should optimize the threshold settings.

Initially, the threshold value is set to a default value of 130 HU which is an empirical value. However, you can freely configure this value yourself.

Hint: If you change the threshold value during Calcium Scoring evaluation you will lose all the evaluation results you have obtained so far.

If you have already performed a Calcium Scoring evaluation for a particular patient and then changed the threshold values, those evaluation results are no longer valid. You will then have to repeat the Calcium Scoring evaluation for that patient.

By browsing through the axial image stack and viewing the MIP Thin, MIP or the MPR reconstruction, you can quickly locate suspected calcification in any of the 4 major coronary arteries.

Hint: Once you have identified calcium plaques in the coronary arteries you improve the image display in both the overview and the detail segment by switching back to the MIP Thin projection.

2.2 Marking

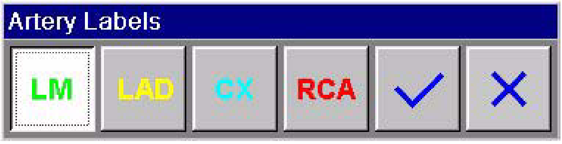
For easier selection when modifying and deleting calcifications, enlarge the images.

Evaluation with Calcium Scoring is based on automatic determination of the amount of calcium in the detected coronary lesions. Evaluation must therefore be preceded by precise marking of the lesions in the individual coronary arteries.

To mark calcifications, you have to edit the images in segment 1. Calcium Scoring offers 2 methods for marking:

– Set seed points for region growing (connected anatomic structures above the given threshold are filled and marked with selection lesion).
– Draw a freehand ROI around a lesion.

After you have pressed **Pick Lesion** or **Freehand ROI** button, the **Artery Labels** dialog box is displayed.

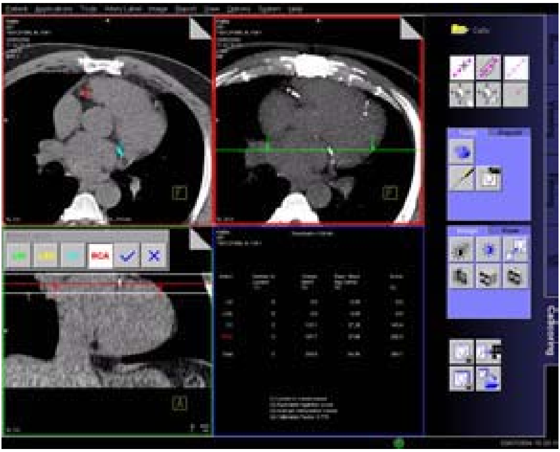


1 2 3 4 5 6

Artery Labels on the Floating Palette

1. **LM** stands for the common branch of the left coronary artery, left main (A. coronaria sinistra).
2. **LAD** stands for the anterior branch of the left coronary artery, left anterior descending (A. coronaria sinistra, R. interventricularus anterior).
3. **CX** stands for the circumflex branch of the left coronary artery (A. coronaria sinistra, R. circumflexus).
4. **RCA** stands for the right coronary artery (A. coronaria dextra).
5. Allows you to assign the marking **Other** to a lesion which does not pertain to the coronary arteries. Lesions to which this marking is assigned are not included in the evaluation but merely highlighted.
6. Allows you to delete a marking that was not correctly assigned.

Continue browsing through the data and mark all other lesions. After checking the lesions (into the depth of the volume) you can correct them if necessary.



2.3 Editing

You can include the entire volume of adjacent pixels of a calcification by marking the detected lesions with **3D Region Growing**.

As a result of 3D region growing calcifications of an artery (e.g., LM) may be assigned wrong markings (e.g., LAD) and may be evaluated as a single lesion due the close proximity to that artery.

You can now edit such a lesion by scrolling to the corresponding slice and splitting it into several parts and assigning the marked parts to the corresponding arteries.

You can either edit a lesion slice by slice with **2D Edit** mode or edit the entire volume of the lesion using **3D Edit** mode. That saves you time-consuming editing of individual slices.

– With 3D editing, you can cut a part of a lesion in the volume and reassign it to another artery label.
– With 2D editing, you can separate mistakenly connected lesions in a slice.
– You can also delete a mistakenly marked lesion.

3. Automatic Result Display

With 3D region growing evaluation, you have selected lesions over a volume and evaluated them as indicated by the markings.

The following measured values are listed in the result table:

- **Artery**
  The label given to the artery, the calcification belongs to.
- **Lesion Index**
  The number of lesions per coronary artery based on the evaluated volume.
- **Volume [mm^3]**
  Interpolated volume for this calcification.
- **Equiv. Mass [mg CaHA]**
  The mass of calcium per coronary artery in mg Ca-HA. To obtain the correct calcium mass, a scanner specific calibration factor is used. A footnote displays the calibration factor.
- **Score**
  Agatston score or equivalent Agatston score (depending on image data).
- You can find additional information with a right mouse click under **Properties**.

A pop up message with appropriate lesion information appears:

- **lesion area**
- **mean CT**
- **peak, volume**
- **score and mass**

The Agatston score represents the amount of detected calcium in each individual coronary artery. For every slice, the area of each lesion is weighed by a factor f which depends on the peak CT value of this lesion:

f = 1 for 130 HU/Peak CT value < 200 HU

f = 2 for 200 HU/Peak CT value < 300 HU

f = 3 for 300 HU/Peak CT value < 400 HU

f = 4 for 400 HU and above

All scores of a specific artery are added for the Agatston score of this artery. All scores of all arteries are added for the total Agatston score.

The original definition of the Agatston score is based on contiguous 3 mm slices. For a study which was acquired with a slice thickness different from 3 mm (e.g., 2.5 mm), or for overlapping slices, an equivalent Agatston score is calculated. It takes the different slice width and interslice distance into account.

Hint: The score table will be updated immediately after you have set a seed point or drawn a freehand ROI, or after any modification or deletion of a calcification marking. The floating score table window appears, whenever you temporarily blow up the display of segment 1. Segment 4 shows the score table for each evaluated arterial label (color-coded).

4. Reporting and Filming

- *The **Report Wizard** helps you to create and export the scoring reports.*

After clicking the **Report Wizard** icon on the **Report** palette, the **Calcium Scoring Report Wizard** pops up.

The current Calcium Scoring report is displayed. Information about the patient (for example, patient name, series number, date of birth) and the score table will automatically be included in the printed report.

You can include up to six images and the result table of the Calcium Scoring evaluation in your report and save them for later documentation.

You can add further text to the report:
– Choose the Referring Physician from the list.
– Choose the Reading Physician from the list.
– Enter/supervise additional information:
  History and Risk Factors.
– Select the desired template.
  You can use customized report templates as well.

Click the **Print** button to finish.

The report is generated and displayed with **List&Label**. You can use this tool, e.g., to print the report, or to save it as HTML file or into a folder of the file system.

You can also copy selected images and results to the **Filming** card.

It is possible to change the layout of the film sheet in the **Filming** card. The **film** task can be exposed either from the **Filming** card or from the **CaScoring** card.

- *Calcium Scoring images or score results are **not saved automatically**.*

Use the **Save All** function or select individual images or the score table to save them. The images are saved as secondary captures in the database.

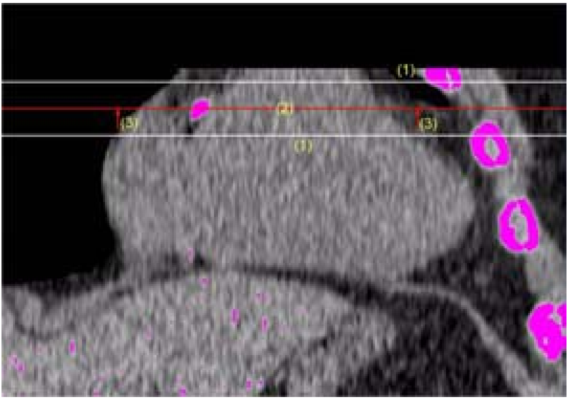
Additional Important Information

Elements of the Sliding MIP Dialog Box

The settings will change the initial thickness of the Sliding MIP in segment 2 or 3.

– **Transaxial Sliding MIP Thickness**
  Sets the thickness (in mm) of the Sliding MIP in segment 2 (axial direction). Default is 20.0 mm.
– **Coronal/Sagittal Sliding MIP Thickness**
  Sets the thickness (in mm) of the MIP in segment 3 (coronal/sagittal direction). Default thickness is 10.0 mm.

Hint: You can graphically adjust the thickness for the Sliding MIP in segment 3. Change the thickness by dragging one of the two parallel (white) lines.



1. *The white slab borders help you to adjust the Sliding MIP.*
2. *The reference line indicates the image displayed in segment 1 and 2.*
3. *The arrows indicate the view/ projection direction.*
   a) Elements of the Threshold Dialog Box

The settings will change the threshold range for coloring pixels to recognize calcification.

– ***Upper Threshold***
  Sets the upper value of the threshold for coloring pixels. Default is 3071 HU.
– ***Lower Threshold***
  Sets the lower value of the threshold for coloring pixels. Default is 130 HU.

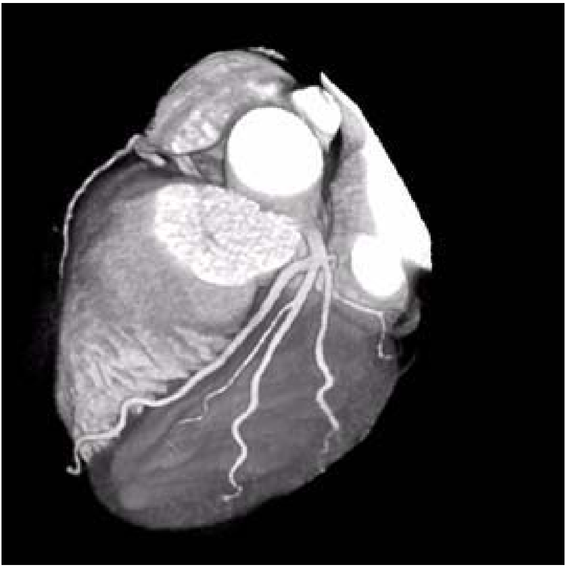
Thickness for 3D Editing

The 3D edit tool allows you to draw a masking volume for the lesions in segment 1. The editing contour is swept up and down at a certain distance to modify the calcification in the volume. The thickness the 3D editing tool works is the current Sliding MIP thickness.

The customization covers:
– The information provided in the report heading
– The reference database used for diagnosis comparison.

During reporting, the Calcium Scoring software automatically adds the patient information and the score table to a copy of the stored template files.
– ***Labeling marked lesions***
Once you have assigned a specific lesion to a coronary artery, you might want to label this calcification for later documentation. You can do that using graphic tools such as lines or arrows and annotation texts.
– Calcium Scoring images or score results are **not saved automatically**. Use the **Save All** function or select individual images or the score table to **Save** them.
– After closing the current evaluation a new status object is created within the last result series (e.g. **CaScoring_SR**).

Scanning



This is an application for imaging the coronary arteries with contrast medium. We recommend using only ECG-gated spiral scanning. The following scan protocols are predefined:

SOMATOM Sensation 64

- **CoronaryCTARoutine033s**
  - Standard spiral protocol using a rotation time of 0.33s
- **CoronaryCTARoutine037s**
  - Standard spiral protocol using a rotation time of 0.37s
- **CoronaryCTAAdaptedSpeed033s**
  - Spiral protocol using a lower pitch of 0.18 for low heart rates in the bisegment reconstruction

- **CoronaryCTAAdaptedSpeed037s**
  - Spiral protocol using a lower pitch of 0.21 for low heart rates in the bisegment reconstruction

SOMATOM Sensation 40:

- **CoronaryCTARoutine037s**
  - Standard spiral protocol using a rotation time of 0.37s
- **CoronaryCTAAdaptedSpeed037s**
  - Spiral protocol using a lower pitch of 0.21 for low heart rates in the bisegment reconstruction

SOMATOM Emotion 6:

- **CoronaryCTARoutine06s**
  - Standard spiral protocol using a rotation time of 0.6s

Contrast Medium

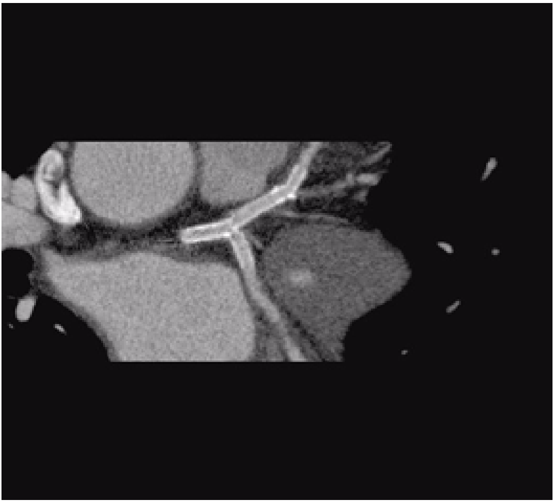
For homogeneous contrast enhancement in the coronary arteries, optimized contrast protocols are mandatory.

The use of bolus tracking is helpful, with an automatic start of the spiral scan as soon as a contrast threshold of 100 – 120 HU has been reached in the ascending aorta. Please note that correct placement of the ROI in the ascending aorta is essential. An example for an optimized contrast protocol is: Use 80 ml of contrast agent with a density of 350 mg/ml at a flow rate of 4 ml/s followed by 80 – 120 ml of saline chaser at a flow rate of 4 ml/s (double head injector).

The use of Test bolus: An example for an optimized contrast protocol is: Use 10 ml of contrast agent with a density of 350 mg/ml at a flow rate of 4 ml/s followed by 60 ml at a flow rate of 4 ml/s of saline chaser (double head injector). For the CTA use 80 ml of contrast agent with a density of 350 mg/ml at a flow rate of 4 ml/s followed by 80 – 120 ml of saline chaser at a flow rate of 4 ml/s (double head injector).

For further information on the Bolus Tracking Application, please refer to the chapter "Contrast Medium".

- We recommend using ECG-gated spiral protocols for optimized image quality of the coronary arteries and to provide high-quality 3D image data as an input for 3D postprocessing such as MPR, MIP, VRT or Fly Through. Although ECG-gated spiral scanning is less sensitive to variable heart rates than ECG-triggered sequential scanning, the examination of patients with complex arrhythmia that results in unpredictable variations of the RR-intervals (e.g. complex ventricular arrhythmia or multiple extra beats) can result in limited image quality and should be performed in exceptional cases only.
- Acquisition with a minimum collimated slice width ensures best possible image quality due to the optimized intrinsic resolution of the scan data. Once high quality scan data has been acquired, the reconstructed slice width has to be optimized with respect to image noise and best possible quality in MPR, MIP and VRT reconstructions.



CoronaryCTARoutine033s

Indications:

A standard spiral protocol with ECG gating using a rotation time of 0.33 sec.

A typical range of 12 cm covering the entire heart can be done in 10.97 sec.

Topogram:
AP, 512 mm. Approximately, from the carina to the apex of the heart.

Sensation 64	CorCTA	2^{nd} reconstr.
kV	*120*	
Effective mAs/ Quality ref. mAs	*770*	
Rotation Time	*0.330 sec.*	
Acquisition	*64 x 0.6 mm*	
Slice collimation	*0.6 mm*	
Slice width	*3.0 mm*	*0.6 mm*
Feed/Rotation	*3.8 mm*	
Pitch Factor	*0.20*	
Increment	*3.0 mm*	*0.4 mm*
Kernel	*B30f*	*B25f*
*Temp. resolution**	*up to 83 ms*	
$CTDI_{Vol}$	*59.3 mGy*	
Effective dose	*Male: 13.45 mSv Female: 17.79 mSv*	

* *depends on heart rate*

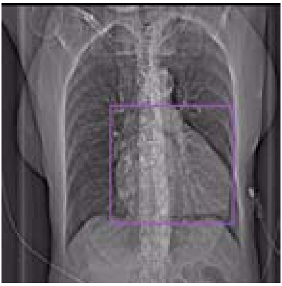
CoronaryCTARoutine037s

Indications:

A standard spiral protocol with ECG gating using a rotation time of 0.37 sec.

For SOMATOM Sensation 64:
A typical range of 12 cm covering the entire heart can be done in 10.52 sec.

For SOMATOM Sensation 40:
A typical range of 12 cm covering the entire heart can be done in 16.38 sec.



Topogram:
AP, 512 mm. Approximately, from the carina to the apex of the heart.

Sensation 64	CorCTA	2nd reconstr.
kV	*120*	
Effective mAs/ Quality ref. mAs	*680*	
Rotation Time	*0.375 sec.*	
Acquisition	*64 x 0.6 mm*	
Slice collimation	*0.6 mm*	
Slice width	*3.0 mm*	*0.6 mm*
Feed/Rotation	*4.6 mm*	
Pitch Factor	*0.24*	
Increment	*3.0 mm*	*0.4 mm*
Kernel	*B30f*	*B25f*
*Temp. resolution**	*up to 94 ms*	
$CTDI_{Vol}$	*52.4 mGy*	
Effective dose	*Male: 11.88 mSv Female: 15.71 mSv*	

* *depends on heart rate*

Sensation 40	CorCTA	2nd reconstr.
kV	*120*	
Effective mAs/ Quality ref. mAs	*680*	
Rotation Time	*0.375 sec.*	
Acquisition	*40 x 0.6 mm*	
Slice collimation	*0.6 mm*	
Slice width	*3.0 mm*	*0.6 mm*
Feed/Rotation	*2.9 mm*	
Pitch Factor	*0.24*	
Increment	*3.0 mm*	*0.4 mm*
Kernel	*B30f*	*B25f*
*Temp. resolution**	*up to 94 ms*	
$CTDI_{Vol}$	*56.4 mGy*	
Effective dose	*Male: 12.80 mSv Female: 16.93 mSv*	

* *depends on heart rate*

CoronaryCTA06s

Indications:

A standard spiral protocol with ECG gating using a rotation time of 0.6 sec.

A typical range of 12.25 cm covering the entire heart can be done in 31.83 sec.

Topogram:
AP, 512 mm. Approximately, from the carina to the apex of the heart.

Emotion 6	**CorCTA**
kV	*130*
Effective mAs/ Quality ref. mAs	*280*
Rotation Time	*0.6 sec.*
Acquisition	*6 x 1.0 mm*
Slice collimation	*1.0 mm*
Slice width	*1.25 mm*
Feed/Rotation	*2.4 mm*
Pitch Factor	*0.40*
Increment	*0.8 mm*
Kernel	*B31s*
Temp. resolution *	*up to 150 ms*
$CTDI_{Vol}$	*36.94 mGy*
Effective dose	*Male: 7.55 mSv* *Female: 10.78 mSv*

* *depends on heart rate*

CoronaryCTAAdaptSpeed033s

Indications:

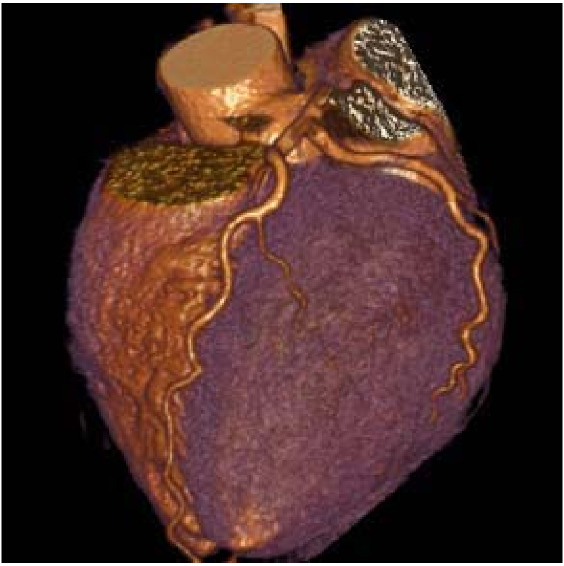
This spiral scanning protocol is identical to CoronaryCTARoutine033s, except that it uses a reduced pitch. It is intended for a low heart rate in the bisegment reconstruction.

A typical range of 12 cm covering the entire heart can be done in 12.12 sec.

Topogram:
AP, 512 mm. Approximately, from the carina to the apex of the heart.

Sensation 64	CorCTA	2nd reconstr.
kV	*120*	
Effective mAs/ Quality ref. mAs	*850*	
Rotation Time	*0.330 sec.*	
Acquisition	*64 x 0.6 mm*	
Slice collimation	*0.6 mm*	
Slice width	*3.0 mm*	*0.6 mm*
Feed/Rotation	*3.5 mm*	
Pitch Factor	*0.18*	
Increment	*3.0 mm*	*0.4 mm*
Kernel	*B30f*	*B25f*
*Temp. resolution**	*up to 83 ms*	
$CTDI_{Vol}$	*65.5 mGy*	
Effective dose	*Male: 14.84 mSv* *Female: 19.64 mSv*	

** depends on heart rate*



CoronaryCTAAdaptSpeed037s

Indications:

This spiral scanning protocol is identical to CoronaryCTARoutine037s, except that it uses a reduced pitch. It is intended for a low heart rate in the bisegment reconstruction.

For SOMATOM Sensation 64:
A typical range of 12 cm covering the entire heart can be done in 11.91 sec.

For SOMATOM Sensation 40:
A typical range of 12 cm covering the entire heart can be done in 18.61 sec.

Topogram:
AP, 512 mm. Approximately, from the carina to the apex of the heart.

Sensation 64	CorCTA	2nd reconstr.
kV	*120*	
Effective mAs/ Quality ref. mAs	*765*	
Rotation Time	*0.375 sec.*	
Acquisition	*64 x 0.6 mm*	
Slice collimation	*0.6 mm*	
Slice width	*3.0 mm*	*0.6 mm*
Feed/Rotation	*4.0 mm*	
Pitch Factor	*0.21*	
Increment	*3.0 mm*	*0.4 mm*
Kernel	*B30f*	*B25f*
*Temp. resolution**	*up to 94 ms*	
$CTDI_{Vol}$	*58.9 mGy*	
Effective dose	*Male: 13.36 mSv* *Female: 17.67 mSv*	

* *depends on heart rate*

Sensation 40	CorCTA	2nd reconstr.
kV	*120*	
Effective mAs/ Quality ref. mAs	*765*	
Rotation Time	*0.375 sec.*	
Acquisition	*40 x 0.6 mm*	
Slice collimation	*0.6 mm*	
Slice width	*3.0 mm*	*0.6 mm*
Feed/Rotation	*2.5 mm*	
Pitch Factor	*0.21*	
Increment	*3.0 mm*	*0.4 mm*
Kernel	*B30f*	*B25f*
*Temp. resolution**	*up to 94 ms*	
$CTDI_{Vol}$	*63.5 mGy*	
Effective dose	*Male: 14.40 mSv Female: 19.05 mSv*	

* *depends on heart rate*

CoronaryCTASeq

Indications:

This is a sequential scanning protocol.

The scan length is 12.25 cm.

Emotion Duo	**CorCTASeq**
kV	*130*
mAs/ Quality ref. mAs	*100*
Rotation Time	*0.8 sec.*
Acquisition	*2 x 2.5 mm*
Slice collimation	*2.5 mm*
Slice width	*2.5 mm*
Feed/Scan	*5.0 mm*
Kernel	*B31s*
Temp. resolution *	*up to 400 ms*
$CTDI_{Vol}$	*10.8 mGy*
Effective dose	*Male: 2.13 mSv* *Female: 3.05 mSv*

* *depends on heart rate*

WorkStream4D Protocols

There are three protocols which have seven recon jobs predefined. Five of these recon jobs are oblique 3D reconstructions for special heartviews.

Additionally there are three protocols which have four recon jobs predefined. Two of these recon job are oblique multiphase reconstruction for creating movies and load them into the **InSpace4D** application.

SOMATOM Sensation 64:

- CoronaryCTAVol033s
- CoronaryCTAVol037s

SOMATOM Sensation 40:

- CoronaryCTAVol037s

Seven Recon jobs are predefined:

1. axial 3 mm slice,
   3 mm increment for filming or archiving
2. axial 0.6 mm slice, increment 0.4 mm for MIPs
3. RAO
   3D Reconstruction for the best LM/LAD view
   with a heart phase of 55%
   Image Type MIP is used.
4. LAO
   3D Reconstruction for the best RCA view
   with a heart phase of 55%
   Image Type MIP is used.
5. CX
   3D Reconstruction for the best LM/LAD/CX
   view (SpiderView) with a heart phase of 55%
   Image Type MIP is used.

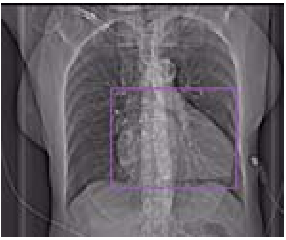
6. ShortAxis
   3D Reconstruction for the best view on the short heart axis
   Multiphase reconstruction of heart phase from 10 to 100%, interval = 10% for ***syngo* Argus**.
   Image Type MPR is used.
7. EjectionFraction
   3D Reconstruction for the best view on the short heart axis
   Multiphase reconstruction of heart phase 20% (systolic) and 80% (diastolic) for ***syngo* Argus**.
   Image Type MPR is used.

CoronaryCTAVol033s

Indications:

This is a spiral scanning protocol, using a rotation time of 0.33 sec., with an ECG gating technique for coronary CTA studies. Use this protocol for the 3D images display view.

A typical range of 12 cm covering the entire heart can be done in 10.97 sec.



Topogram:
AP, 512 mm. Approximately, from the carina to the apex of the heart.

Sensation 64	CorCTA	2nd recon.	3rd recon.
kV	*120*		
Effective mAs/ Quality ref. mAs	*770*		
Rotation Time	*0.330 sec.*		
Acquisition	*64 x 0.6 mm*		
Slice collimation	*0.6 mm*		
Slice width	*3.0 mm*	*0.6 mm*	*2.0 mm*
Feed/Rotation	*3.8 mm*		
Pitch Factor	*0.20*		
Increment	*3.0 mm*	*0.4 mm*	*2.0 mm*
Kernel	*B30f*	*B25f*	*B30f*
*Temp. resolution**	*up to 83 ms*		
$CTDI_{Vol}$	*59.3 mGy*		
Effective dose	*Male: 13.45 mSv Female: 17.79 mSv*		

* *depends on heart rate*

Sensation 64	4th reconstr.	5th reconstr.
Slice width	*2.0 mm*	*2.0 mm*
Increment	*2.0 mm*	*2.0 mm*
Kernel	*B30f*	*B30f*

Sensation 64	6th reconstr.	7th reconstr.
Slice width	*8.0 mm*	*8.0 mm*
Increment	*8.0 mm*	*8.0 mm*
Kernel	*B30f*	*B30f*

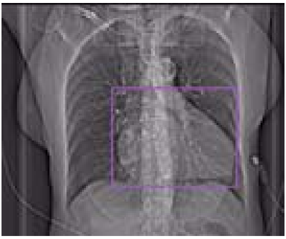
CoronaryCTAVol037s

Indications:

This is a spiral scanning protocol, using a rotation time of 0.37 sec., with an ECG gating technique for coronary CTA studies. Use this protocol for the 3D images display view.

For SOMATOM Sensation 64:
A range of 12 cm including the aorta arch will be covered in 10.52 sec.

For SOMATOM Sensation 40:
A range of 12 cm including the aorta arch will be covered in 16.38 sec.



Topogram:
AP, 512 mm. Approximately, from the carina to the apex of the heart.

Sensation 64	CorCTA	2nd recon.	3rd recon.
kV	*120*		
Effective mAs/ Quality ref. mAs	*680*		
Rotation Time	*0.375 sec.*		
Acquisition	*64 x 0.6 mm*		
Slice collimation	*0.6 mm*		
Slice width	*3.0 mm*	*0.6 mm*	*2.0 mm*
Feed/Rotation	*4.6 mm*		
Pitch Factor	*0.24*		
Increment	*3.0 mm*	*0.4 mm*	*2.0 mm*
Kernel	*B30f*	*B25f*	*B30f*
*Temp. resolution**	*up to 94 ms*		
$CTDI_{Vol}$	*52.4 mGy*		
Effective dose	*Male: 11.88 mSv Female: 15.71 mSv*		

* *depends on heart rate*

Sensation 64	4th reconstr.	5th reconstr.
Slice width	*2.0 mm*	*2.0 mm*
Increment	*2.0 mm*	*2.0 mm*
Kernel	*B30f*	*B30f*

Sensation 64	6th reconstr.	7th reconstr.
Slice width	*8.0 mm*	*8.0 mm*
Increment	*8.0 mm*	*8.0 mm*
Kernel	*B30f*	*B30f*

Sensation 40	CorCTA	2nd recon.	3rd recon.
kV	*120*		
Effective mAs/ Quality ref. mAs	*680*		
Rotation Time	*0.375 sec.*		
Acquisition	*40 x 0.6 mm*		
Slice collimation	*0.6 mm*		
Slice width	*3.0 mm*	*0.6 mm*	*2.0 mm*
Feed/Rotation	*2.9 mm*		
Pitch Factor	*0.24*		
Increment	*3.0 mm*	*0.4 mm*	*2.0 mm*
Kernel	*B30f*	*B25f*	*B30f*
*Temp. resolution**	*up to 94 ms*		
$CTDI_{Vol}$	*56.4 mGy*		
Effective dose	*Male: 12.80 mSv Female: 16.93 mSv*		

* *depends on heart rate*

Sensation 40	4th reconstr.	5th reconstr.
Slice width	*2.0 mm*	*2.0 mm*
Increment	*2.0 mm*	*2.0 mm*
Kernel	*B30f*	*B30f*

Sensation 40	6th reconstr.	7th reconstr.
Slice width	*8.0 mm*	*8.0 mm*
Increment	*8.0 mm*	*8.0 mm*
Kernel	*B30f*	*B30f*

Aortic and Pulmonary Studies

The purpose of these applications is to reduce motion artifacts in the lung, the aorta and the pulmonary arteries due to transmitted cardiac pulsation. It is intended for imaging the aorta and pulmonary arteries with contrast medium ECG-gated spiral scanning, e.g. for aortic dissection or pulmonary emboli. The following scan protocols are predefined:

You will find these protocols under body region: **Vascular**

SOMATOM Sensation 64:

- **ThorCardioECG033s**
  - Spiral scanning protocol with ECG gating and a rotation time of 0.33 sec.
- **ThorCardioECG037s**
  - Spiral scanning protocol with ECG gating and a rotation time of 0.37 sec.

SOMATOM Sensation 40:

- **ThorCardioECG037s**
  - Spiral scanning protocol with ECG gating and a rotation time of 0.37 sec.

SOMATOM Sensation Open:

- **ThorCardioECG05s**
  - Spiral scanning protocol with ECG gating and a rotation time of 0.5 sec.

SOMATOM Emotion 6:

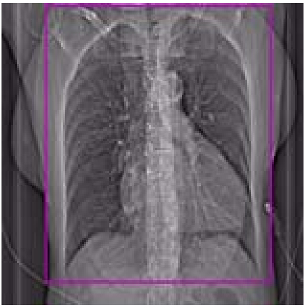
- **ThorAngioECG06s**
  - Spiral scanning protocol with ECG gating and a rotation time of 0.6 sec.
- **ThorAngioECGSeq**
  - Sequential scanning protocol with ECG triggering and a rotation time of 0.8 sec.

ThorCardioECG033s

Indications:

This is a spiral scanning protocol using an ECG gating technique and a rotation time of 0.33 sec. for aortic and pulmonary studies combined with coronary studies.

A range of 25 cm including the aorta arch will be covered in 14.98 sec.



Topogram:
AP, 512 mm. Approximately, from the carina to the apex of the heart.

Sensation 64	ThorCorECG	2nd reconstr.
kV	*120*	
Effective mAs/ Quality ref. mAs	*570*	
Rotation Time	*0.330 sec.*	
Acquisition	*64 x 0.6 mm*	
Slice collimation	*0.6 mm*	
Slice width	*3.0 mm*	*0.60 mm*
Feed/Rotation	*5.8 mm*	
Pitch Factor	*0.30*	
Increment	*3.0 mm*	*0.40 mm*
Kernel	*B30f*	*B25f*
*Temp. resolution**	*up to 83 ms*	
$CTDI_{Vol}$	*43.9 mGy*	
Effective dose	*Male: 16.90 mSv Female: 22.16 mSv*	

** depends on heart rate*

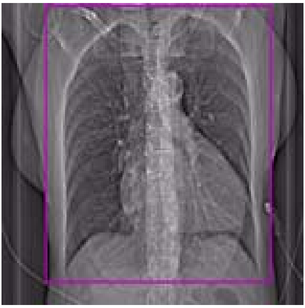
ThorCardioECG037s

Indications:

This is a spiral scanning protocol using an ECG gating technique and a rotation time of 0.37 sec. for aortic and pulmonary studies combined with coronary studies.

For SOMATOM Sensation 64:
A range of 25 cm including the aorta arch will be covered in 15.11 sec.

For SOMATOM Sensation 40:
A range of 25 cm including the aorta arch will be covered in 23.73 sec.



Topogram:
AP, 512 mm. Approximately, from the carina to the apex of the heart.

Sensation 64	ThorCorECG	2nd reconstr.
kV	*120*	
Effective mAs/ Quality ref. mAs	*570*	
Rotation Time	*0.375 sec.*	
Acquisition	*64 x 0.6 mm*	
Slice collimation	*0.6 mm*	
Slice width	*3.0 mm*	*0.60 mm*
Feed/Rotation	*6.5 mm*	
Pitch Factor	*0.34*	
Increment	*3.0 mm*	*0.40 mm*
Kernel	*B30f*	*B25f*
*Temp. resolution**	*up to 94 ms*	
$CTDI_{Vol}$	*43.9 mGy*	
Effective dose	*Male: 16.90 mSv* *Female: 22.16 mSv*	

* *depends on heart rate*

Sensation 40	ThorCorECG	2nd reconstr.
kV	*120*	
Effective mAs/ Quality ref. mAs	*490*	
Rotation Time	*0.375 sec.*	
Acquisition	*40 x 0.6 mm*	
Slice collimation	*0.6 mm*	
Slice width	*3.0 mm*	*0.60 mm*
Feed/Rotation	*4.1 mm*	
Pitch Factor	*0.34*	
Increment	*3.0 mm*	*0.40 mm*
Kernel	*B30f*	*B25f*
*Temp. resolution**	*up to 94 ms*	
$CTDI_{Vol}$	*40.7 mGy*	
Effective dose	*Male: 15.66 mSv* *Female: 20.54 mSv*	

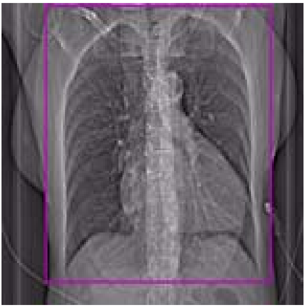
* *depends on heart rate*

ThorCardioECG05s

Indications:

This is a spiral scanning protocol using an ECG gating technique and a rotation time of 0.5 sec. for fast aortic studies combined with coronary studies.

A range of 25 cm including the aorta arch will be covered in 24.15 sec.



Topogram: AP, 512 mm. From the aortic arch to the apex of the heart.

Sensation Open	ThorCorECG	2nd reconstr.
kV	*120*	
Effective mAs/ Quality ref. mAs	*440*	
Rotation Time	*0.500 sec.*	
Acquisition	*40 x 0.6 mm*	
Slice collimation	*0.6 mm*	
Slice width	*3.0 mm*	*1.0 mm*
Feed/Rotation	*5.4 mm*	
Pitch Factor	*0.45*	
Increment	*3.0 mm*	*0.70 mm*
Kernel	*B30f*	*B25f*
*Temp. resolution**	*up to 125 ms*	
$CTDI_{Vol}$	*48.0 mGy*	
Effective dose	*Male: 17.39 mSv Female: 23.14 mSv*	

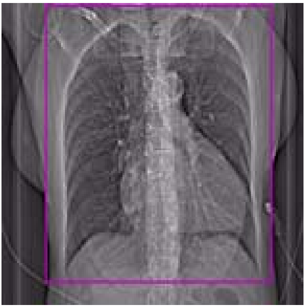
** depends on heart rate*

ThorAngioECG06s

Indications:

This is a spiral scanning protocol using an ECG gating technique and a rotation time of 0.6 sec. for aortic and pulmonary studies.

A range of 15 cm including the aorta arch will be covered in 19.95 sec.



Topogram:
AP, 512 mm. From the aortic arch to the apex of the heart.

Emotion 6	ThorECG	2nd reconstr.
kV	*130*	
Effective mAs/ Quality ref. mAs	*115*	
Rotation Time	*0.6 sec.*	
Acquisition	*6 x 2.0 mm*	
Slice collimation	*2.0 mm*	
Slice width	*5.0 mm*	*2.5 mm*
Feed/Rotation	*4.8 mm*	
Pitch Factor	*0.40*	
Increment	*5.0 mm*	*1.5 mm*
Kernel	*B31s*	*B31s*
*Temp. resolution**	*up to 150 ms*	
$CTDI_{Vol}$	*13.05 mGy*	
Effective dose	*Male: 3.35 mSv* *Female: 4.43 mSv*	

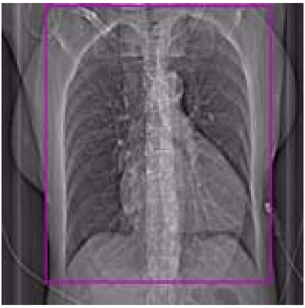
* *depends on heart rate*

ThorAngioECGSeq

Indications:

This is a sequential scanning protocol with an ECG triggering technique for aortic and pulmonary studies.

The scan length is 29.9 cm.



Topogram:
AP, 512 mm. From the aortic arch to the apex of the heart.

Emotion 6	**ThorAngio**
kV	*130*
mAs/ Quality ref. mAs	*80*
Rotation Time	*0.8 sec.*
Acquisition	*6 x 1.0 mm*
Slice collimation	*1.0 mm*
Slice width	*1.0 mm*
Feed/Scan	*6.0 mm*
Kernel	*B31s*
*Temp. resolution**	*up to 400 ms*
$CTDI_{Vol}$	*10.56 mGy*
Effective dose	*Male: 7.19 mSv Female: 9.35 mSv*

** depends on heart rate*

4D Viewer

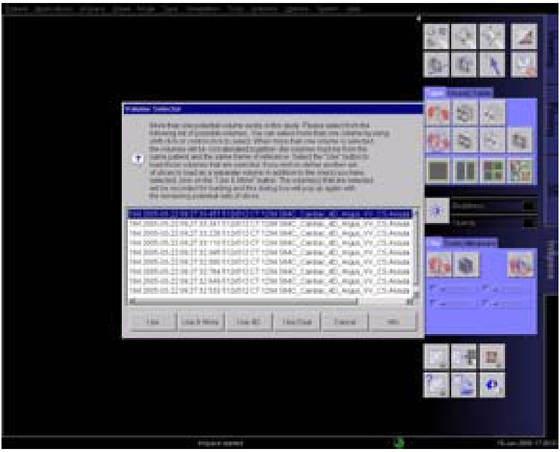
Please use the standard scan protocols with the suffix "Vol". For further information please refer to the chapter "CoronaryCTA-WorkStream4D protocols".

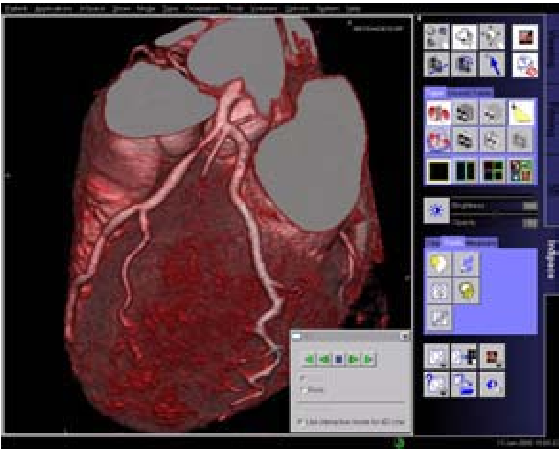
In addition to its unique performance in displaying huge static CT volume data sets, the new ***syngo* InSpace4D** offers true 4-dimensional evaluation of the heart, based on data reconstructed in up to 24-phases of the cardiac cycle.

The software enables real-time visualization and diagnosis of the beating heart, evaluation of functional defects, and navigation in any arbitrary plane.

4D reading is achieved using either clip planes or slabs that can be positioned interactively in order to show, in real-time, the desired anatomy.

Select multiple time-sequence volumes from the local database (axial multiphase series). For further information about the reconstruction, please refer to the chapter "Multiphase". Load these series into ***syngo* InSpace** and select **Use 4D** from the study purifier.





For further information about the application ***syngo* InSpace4D**, please refer to the Application Guide "Clinical Applications 2".

***syngo* Vessel View** is a dedicated tool for 3D visualization and analysis of vascular structures in MR and CT data sets.

In addition to vessel analysis, this option is also useful for pre-surgical evaluation, which requires direct measurements in a 3D-volume data set.

Key Features

- 3D visualization with MPRs, MIPs, and Volume Rendering.
- VRT presets shared with the common gallery available with the ***syngo* VRT** option on the **3D** card.
- 3D editing with clip planes or VOI punching.
- Semi-automatic segmentation of complete vessel trees & intuitive path planning.
- Manual path planning along the vessel & manual vessel segmentation with the Tube Mode.
- Vessel Navigator which creates a Ribbon MPR for close-up evaluation of the vessel.
- Display up to 3 flags at the normal and minimum diameters or cross-sectional areas of the vessel.
- Automatic calculation of the stenotic ratio in percent.
- Straight & curved distance measurements directly in the Vessel Navigator or in the VRT segment.

- Angle measurements directly in the volume segment.
- Automatic contour detection and area calculation of the vessel lumen orthogonal to the center line path.
- The quantification results are summarized in output tables (Reports) that can be documented as hardcopy or stored together with the corresponding images in the database.
- Setting of annotation texts either along the path in the VRT segment or anywhere in the 3D volume in the MPR segments to identify anatomically important coordinates.

Prerequisites

Volume data set with good opacification for vascular analysis, with overlapping thin slice and a soft kernel reconstruction are recommended.

To ensure optimal enhancement after the contrast medium injection a Test bolus or Bolus Tracking using **CARE Bolus** (optional) should be used. For the coronary vessels and the large thoracic vessels, best results can be achieved with ECG-synchronized scanning using the **Heart View CT**.

Workflow

Loading the Images

After loading the images into ***syngo* Vessel View** the following layout is displayed:

<table>
<tr><td colspan="3">Menu Bar</td></tr>
<tr><td>MPR
Segment
Sagittal View</td><td rowspan="2">MPR
Segment
Axial View</td><td rowspan="3">Control
Area</td></tr>
<tr><td>MPR
Segment
Coronal View</td></tr>
<tr><td>Volume
Segment</td><td>Measurements or
Vessel Navigator</td></tr>
<tr><td colspan="3">Status Bar</td></tr>
</table>

MPR Segments

The three small segments on the left are referred to as MPR Segments although these segments may also display MIP Thin and MPR Thick. These segments contain manipulator lines, as in the **3D** card, which allow you to rotate and translate image planes. 2D measurements are also possible on these segments.

Volume Segment

This segment displays the complete volume data set either in VRT or MIP representation.

Hint: VRT presets are shared with the common gallery available with the VRT option on the **3D** card. Since **Vessel View** applies a different volume rendering algorithm that provides no "shaded" display like the **3D** card, it may be helpful to create and save your specific Vessel View VRT settings.

A green arrow, the so-called Focus Pointer indicates the current position in the volume, e.g. for creation of annotation texts. The Focus Pointer also indicates the intersection point of the three MPR segments.

The orientation cube in the lower right corner may be used to quickly change the orientation of the volume data set. A single click on one side of the cube will set the orientation of the volume to that side. A double-click anywhere on the cube will set the orientation and the zoom factor of the volume back to their default values.

Vessel Navigator

The Vessel Navigator shows a longitudinal cut along the center line of the vessel. An area curve of the vessel's cross-sectional area is displayed as a graphical overlay on the Vessel Navigator image.

You can move along the vessel and rotate the Vessel Navigator image about the vessel axis. The Focus Pointer (known from the Volume Segment) is represented by a green vertical line.

When moving the Focus Pointer, the three MPR Segments are synchronized to the position of the Focus Pointer.

Visualization

This step is used to get an initial impression of the data set and, if necessary, remove structures which hide the view on the structures of interest.

To get an initial impression of the data set, you may view it in VRT or MIP representation in the Volume Segment or page through the data set in the MPR Segments.

Working with the VRT/MIP representation in the Volume Segment you may typically

- Apply a VRT preset from the **VRT Gallery**.
- Create his own VRT preset.
- Change the **W/C** setting with the middle mouse button.
- Freely rotate the volume.
- Click on the Orientation Cube to quickly set the orientation to desired standard views.
- Blow up the Volume Segment to full screen size.

Working with the MPR Segments you may typically

- Page through the axial, sagittal and coronal views.
- Change the views to any oblique/double-oblique view.
- Change the **W/C** setting with the middle mouse button.
- Blow up one MPR Segment to go to the Volume Segment.

Working with the Vessel Navigator you may typically

- Change **W/C** setting with the middle-mouse button.
- Change the **Ribbon Viewer** width (if less than the full vessel width or not enough surroundings are shown).
- Zoom/Pan to display the region of interest.
- Display curves of either the cross-sectional area of the vessel or a combination of the minimum, maximum and equivalent diameters along the vessel’s center line.
- Measure straight distances perpendicular to the vessel (e.g. diameter of the vessel).
- Measure curved distances along the vessel’s center line.
- Rotate the Ribbon MPR step by step or in **cine** mode.
- Change the display to MIP Thin.

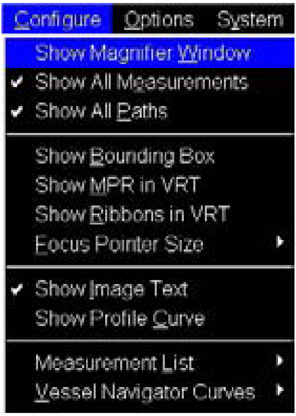
To remove unwanted structures you may

- Punch out unwanted structures.
- Apply clip planes.

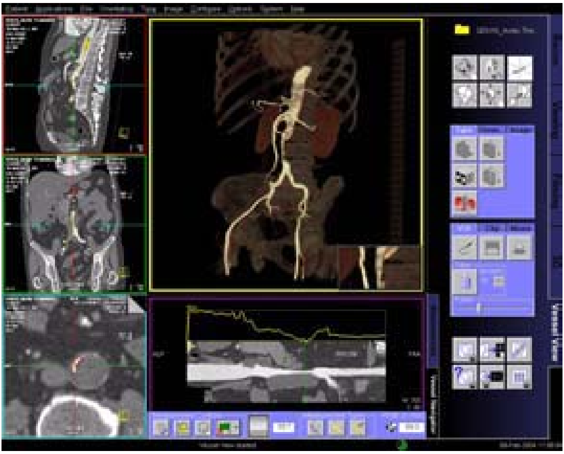
Segmentation

In this step, you place certain seed points in order to identify the vessel of interest and define paths along its center line. These paths can be the result of a semi-automatic or fully manual segmentation procedure.

– Select **Configure > Show Magnifier Window** from the main menu to set the seed points easier, mainly on small vessels.



You can drag & drop the Magnifier window to any position on the screen.



a) Semi-Auto Segmentation

With the Semi-Auto Segmentation all path points are automatically set by the application.

Segmentation steps:

Step 1: Select the vessel type that you want to segment (aorta, carotids, coronaries or other).

The segmentation algorithm is adapted to the vessel type you selected.

Hint

Do not select **Other** as the segmentation may abort.

Step 2: Set one or more seed points.

There are two different types of seed points:
Center points – e.g. one click for the complete aorta
End points – e.g. prevents the segmentation to run from carotids into aortic arch.
You can set points in all segments.
You may set any number of center points and/or end points. For the segmentation of coronaries, two end points have to be set.

Step 3: Adjust sensitivity (threshold for segmentation).

Set the required threshold value with the slider.

Voxels of an intensity below the segmentation threshold are excluded from the image segment. Check the view and correct the setting if necessary.

Step 4: Define paths along the branches of the vessel tree by performing two clicks into the VRT image for each path. You may define as many paths as necessary.

As soon as you have created all paths click **Done**.

Paths are displayed in the image segments as a colored line through the middle of the vessel.

You only have to:

– Position one or more seed points anywhere in the vessel of interest via the left mouse button.
– Position individual seed points in the most suitable image segment (Volume or MPR segment).
– Position an end point where vessel branches run into other vessels, if necessary.
– In many cases, e.g. the aorta, only one seed point is necessary to trace the whole vascular tree.
– Adjust the threshold to remove bone or any other unwanted structures. The segmentation algorithm automatically finds the vessel limits and determines the whole vessel tree.
– As a last step, plan as many paths as wanted in the Volume segment.

Hint

For an optimal performance of the segmentation algorithm:

Limit the size and especially the complexity of the vasculature that you would like to segment.

To achieve this:

- Place at least two end points during the segmentation workflow. One end point proximal and one distal to the vasculature of interest.
- After the segmentation modify the HU threshold by moving the slider that only the vessels of interest are visible and all bones are excluded.

For some cases where the vessels are completely occluded, it may be not possible to define a path along these vessels after segmentation. As a workaround you can use the **Manual Path Creation**.

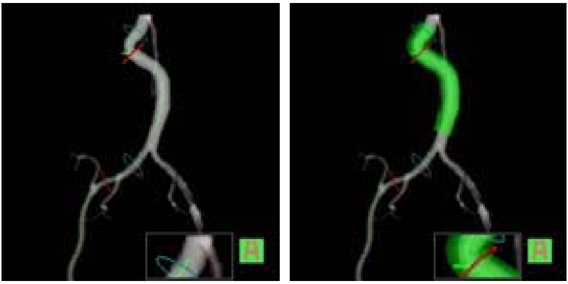
b) Manual mode

With the manual mode all path points have to be set by you.

– Position path points at the beginning of a vessel and wherever the vessel changes its course and at the end of the vessel.
– Position the individual path points in the most suitable image segment. (Volume or MPR segment).
– For the identification of branched vessels, position a path point where the branches join.

Depending on the number as well as accuracy used in positioning the path points, the paths represents the actual course of the blood vessel.

Manual mode does not isolate the vessel tree from the surrounding tissue and bones. For this purpose **Tube** Mode may be used.



Path Modification

After segmentation has been completed, each path is given a unique name. You may modify the path name, e.g. to an anatomical name and add an explanatory note to each path.

To improve the visibility of paths the translucent mode is automatically switched on after segmentation.

You can modify the course of a path in the Volume or the MPR Segment by using the **Edit** entry in the context sensitive menu (right mouse button).

Measurement Analysis

Flags

Flags are special area measurements. There are usually two or three flags associated with each path, but they can also be turned off completely. You can move them in the **Vessel Navigator** to healthy (one or two flags, called **Normal A** and **Normal B**) and stenotic (the flag called **Minimum**) parts of the vessel.

When their contours (on the Vessel Orthogonal MPR) are accepted their values are displayed in the **Measurement** List. Accepted area measurements and flags are shown as (planar) contours in the Volume Segment.
They have the same color as their MPR counterpart.

Stenosis Ratio Values

Each path has a variable number of **Stenotic Ratio** values displaying the ratio of the **Minimum** flag to the average of the **Normal A** flag and the **Normal B** flag (if available).

Which parts of the flags are used for this ratio – area, minimum diameter, maximum diameter and/or equivalent diameter, is determined globally in the configuration dialog.

The value that is displayed is actually 100% minus the ratio (following the NASCET criteria), resulting in a perfectly healthy vessel being assigned a 0% stenosis and a totally obstructed vessel being assigned a 100% stenosis.

These values only appear in the list after the flags' contours are accepted (= validated). The names are automatically created, incrementing a number at the end. The name can then be changed by you.

Navigation along a path

After creating a path the MPR Segments are automatically set to the **Vessel Orthogonal Orientation**.
This means that the previously standard axial view will now be a view orthogonal to the center line of the vessel; the previous standard coronal and sagittal views are now views tangential to the center line of the vessel.

You have the ability to switch back to the **Patient Orthogonal Orientation**. This means that the MPR Segments remain in the true orthogonal orientations (axial, sagittal, coronal view) as you scroll along the path.

You can set the MPR Segments individually to display the current view in MPR, MIP, MPR Thick or MIP Thin representation.

Using the Focus Pointer you can move along the path and follow the Vessel Orthogonal MPR Segments.

Tube

Tube is a clipping tool, which creates a cylindrical volume following the center line of the selected vessel. The radius of the tube can be selected by you. Tube provides a quick way to either keep the tube volume (= the volume around the vessel) and remove the surrounding structures, or to remove the tube volume and keep the surrounding structures.

Usually this only makes sense after a manual path creation, because the segmentation does a more precise job in separating vessel from surrounding tissue.

Fader

Removed parts of the volume are not really deleted from the data set. Instead, they are hidden by the Fader. With the Fader, you may modify the transparency of the removed volume.

Axial Cuts

This button is only enabled (ungrayed) when a path is selected.

– The FoV of the axial MPR image represents the FoV of the resulting Axial Cuts range: Zoom/pan the path orthogonal MPR image to the best view, then select button **Axial Cuts** in the control area.
– You can specify the begin and end of the range (in mm).
– You can enter a distance between the cuts. The system calculates the resulting number of slices (images).
– While this dialog is open, the VRT shows the location of the cuts as squares.
– Pressing **Cancel** hides the dialog and the squares in the VRT segment.
– Pressing **Start** saves the images to the database.

Performing measurements

You can

- Measure straight distances in MPR and VRT views and on the **Vessel Navigator** (VN)
- Measure curved distances in VRT view and on the VN
- Perform automatic measurements of the vessel's cross-sectional area. After semi-automatic segmentation, a colored vessel contour is displayed on the vessel-orthogonal MPR view. You can accept this contour as official contour.
- Draw and evaluate free-hand ROIs
- Modify existing contours
- Measure angles
- Measure volume

You can hide measurements and show them again with the menu options **Configuration Show > Show All Measurements**.

Documentation of Results

The buttons **Save to Database** and **Copy to Filmsheet** are always available. You can always document intermediate results using these two buttons.

Hint: **Save to Database** and **Copy to Film Sheet** is always applied to the currently selected segment. Make sure that the correct segment is selected.

Save Session and Load Session

Use the menu option **File/Save Session** to save intermediate results of a Vessel View session. Restore the session by first loading the patient images to **Vessel View** and then selecting **File > Load Session**.

Do not delete the series **VVIEW_NONIMAGE_SERIES** until you have fully completed the evaluation of your patient. This series contains non-image data which is required by the **Load Session** function to restore a previously interrupted session.

Create report

The **Report** button creates several output tables of the measurement results. These tables are automatically stored to the database and can be sent to the film sheet.

Graphical documentation of measurements

The **Measurement** list displays all measurements created in this session. Selecting an entry of this list will display the VRT and MPR images associated with this measurement. You can then apply the buttons **Save to Database** and **Copy to Filmsheet** to the relevant segments.

AVI-File of Volume Segment and Vessel Navigator image

You can generate an avi-file of the Volume Segment or the Vessel Navigator image rotating around the vessel axis depending on which segment is currently selected.

For movie creation **Vessel View** uses the MPEG-4 Codec V1. This codec must be installed on the PC on which the movie is to be replayed.

Case Examples

Workflow for an Aortic Aneurysm Case

Visualization

Use VRT settings and window settings for good visualization of the aortic and iliac arteries.

Adjust the VRT view by using presets from the **VRT Gallery**. You can fine-tune the settings by adjusting the trapezoids in the **definition** card.

If necessary, remove unwanted volume structures by using the **Clip Plane** or the **VOI Punch** function.

Hint: Removed parts of the volume are not really deleted from the data set. Instead, they are hidden by the Fader. With the Fader you can modify the transparency of the removed volume parts.

Semi-Automatic Segmentation

Activate the semi-automatic segmentation mode.

Place center seed points into the aorta. In many cases, one seed point is sufficient. Place the seed points either in the MPR segments or in the VRT segment.

As soon as you press the **Next** button, an automatic segmentation will be performed and keep mainly the aortic lumen. After segmentation, the translucent mode is automatically switched on.

Define paths along the aorta or other vessel branches by two clicks for each path.

Editing & Merging Paths

Following segmentation of the aorta, the resultant paths are shown as a list on the **Measurement** card.

You can edit the paths by repositioning the path points along the path into the center of the vessel lumen.

You can also merge paths by selecting two paths from the **Measurement** card at a time and clicking the **Merge** button.

Measurements

Select the path of interest on the **Measurement** card.

Move the Focus Pointer, e.g. by dragging the green vertical line in the **Vessel Navigator**.

The 3 MPR segments are now displayed orthogonal to the path. These images will be updated as you change the position of the Focus Pointer.

The following measurements can be performed:

1. Curved Distance directly in the **Vessel Navigator** e.g. origins of the renal arteries to neck of the aneurysm.
2. Curved Distance in the central long axis of the aneurysm between the upper and lower necks of the aneurysm.
3. Straight Distance for maximum diameter of the aneurysm or any of the aortic branches, i.e. the iliac arteries.
4. Automatic contouring and area calculation of the lumen of the aneurysm or the aortic branches, i.e. the iliac arteries.
5. Angle Measurement

Hint

For the evaluation of very large findings, e.g. aortic dissections, where the accuracy of 3D measurements is sufficient, we recommend to reformat MIPs/MPRs in ***syngo* 3D**.

Workflow for a Coronary Case, e.g. LM and LAD

In the area of the coronary vessels and the large thoracic vessels, best results can be achieved with ECG-synchronized images using the HeartView CT software. Motion artifacts which typically occur in the coronary vessels and in the large thoracic vessels can thus be avoided.

Prerequisite for the evaluation is an optimum enhancement in the vessels of interest. We recommend using **Bolus Tracking**.

We recommend using a heart phase where the vessels of interest are best displayed. Also a smooth kernel is recommended.

Visualization

Use VRT settings and window settings for good visualization of the Left Main (LM) and the Left Anterior Descending Artery (LAD).

Adjust the VRT view by using presets from the **VRT Gallery**. You can fine-tune the settings by adjusting the trapezoids in the **definition** card.

If necessary, remove unwanted volume structures by using the **Clip Plane** or the **VOI Punch** function.

Hint: Removed parts of the volume are not really deleted from the data set. Instead, they are hidden by the Fader. With the Fader you can modify the transparency of the removed volume parts.

Change all MPR segments to 5 mm MIP Thin for better visualization of the coronary arteries.

Semi-Automatic Segmentation

Activate the semi-automatic segmentation mode.

Place two end points into the ascending aorta, one above and one below the bifurcation of the coronary arteries.

Hint: If you place the seed points in the MPR segments, you do not need to isolate the heart in the VRT segment. Make sure you switch the MPR segments from 5 mm MIP Thin back to standard MPR prior to placing the seed points as seed points cannot be placed on MIP Thin or MIP images.

If there are a lot of calcifications or a bypass is visible in the coronaries:
– Set two end points into the aorta, one above and one below the orifices of the coronaries.
– Set several center points after the calcifications or bypass directly into the coronaries

As soon as you press the **Next** button, an automatic segmentation will be performed and keep mainly the coronary tree and part of the ascending aorta. After segmentation, the **translucent** mode is automatically switched on.

Define paths along the coronaries with two clicks for each path.

Editing & Merging Paths

Following segmentation of the aorta, the resultant paths are shown as a list on the **Measurement** card.

You can edit the paths by repositioning the path points along the path into the center of the vessel lumen.

You can also merge paths by selecting two paths from the **Measurement** card at a time and clicking the **Merge** button.

Measurements

Select the **Vessel Navigator** for close-up evaluation of the coronary artery.

A Ribbon/Longitudinal MPR along the path is displayed.

Zoom up the MPR display to the region of interest e.g. a stenosis in the vessel.

You can rotate the MPR plane by using the **Movie** function. Choose a plane that demonstrates the tightest stenosis.

You can move the Focus Pointer along the vessel by dragging the green vertical line in the **Vessel Navigator**.

The following measurements can be performed:

1. On the **Vessel Navigator**, vessel diameters at the stenosis as well as proximal and distal to the stenosis by placing straight distance measurements.
2. On the **Vessel Navigator**, length of the stenosis along the vessel center line by measuring the curved distance between the proximal and distal positions of the narrowing.
3. On MPR views, luminal areas at the stenosis (narrowest part of the vessel), proximal and distal to the stenosis by using the automatic contouring and area calculation functions.

For a more accurate evaluation, it is essential to repeat the measurements from a second plane, at 90° to the first plane. This is essential in assessing a lesion with non-concentric narrowing.

Workflow for a Carotid Stenosis Case

Visualization

Use VRT settings and window settings for good visualization of the carotids.

Adjust the VRT view by using presets from the **VRT Gallery**. You can fine-tune the settings by adjusting the trapezoids in the definition card.

If necessary, remove unwanted volume structures by using the **Clip Plane** or the **VOI Punch** function.

Hint: Removed parts of the volume are not really deleted from the data set. Instead, they are hidden by the Fader. With the **Fader** you can modify the transparency of the removed volume parts.

Semi-Automatic Segmentation

Activate the semi-automatic segmentation mode.

Place center seed points into the carotid of interest. In many cases, one seed point is sufficient. Place the seed points either in the MPR segments or in the VRT segment.

As soon as you press the **Next** button, an automatic segmentation will be performed and keep mainly the aortic lumen. After segmentation, the translucent mode is automatically switched on.

Define paths along the carotid by two clicks for each path.

Editing & Merging Paths

Following segmentation of the aorta, the resultant paths are shown as a list on the **Measurement** card.

You can edit the paths by repositioning the path points along the path into the center of the vessel lumen.

You can also merge paths by selecting two paths from the **Measurement** card at a time and clicking the **Merge** button.

Measurements

Select the **Vessel Navigator** for close-up evaluation of the carotids.

A Ribbon/Longitudinal MPR along the path is displayed.

Zoom up the MPR display to the region of interest e.g. a stenosis in the vessel.

You can rotate the MPR plane by using the **Movie** function. Choose a plane that demonstrates the tightest stenosis.

You can move the Focus Pointer along the vessel by dragging on the green vertical line in the **Vessel Navigator**.

The following measurements can be performed:

1. On the **Vessel Navigator**, vessel diameters at the stenosis as well as proximal and distal to the stenosis by placing Straight Distance measurements.
2. On the **Vessel Navigator**, length of the stenosis along the vessel center line by measuring the curved distance between the proximal and distal positions of the narrowing.
3. On MPR views, luminal areas at the stenosis (narrowest part of the vessel), proximal and distal to the stenosis by using the automatic contouring and area calculation functions.

Additional Important Information

Image quality

In images of poor image quality (due to strong artefacts or non optimal bolus timing) it might occur that the algorithms are not able to segment the whole structure.

Functions

Some functions are only available if a path is selected.

Select a path in the path list on the **Measurements** card, if necessary. In order to increase the accuracy of user-defined measurements, use the **Zoom/Pan** function whenever possible.

This especially helps you to identify the contours of very small vessels.

- To return to the original (coronal) view of the volume double-click anywhere on the orientation cube.
- Select **Configure > Show Magnifier Window** from the main menu to display the **Magnifier** Window for setting the seed points easier, mainly on small vessels.
- Make sure that the points for the segmentation are placed exactly inside the vessel. Also, do not use too many points; in most of the cases one seed point is enough depending on the vessel anatomy.

- If no image is displayed in the **Vessel Navigator**, simply select the path from the **Measurement** list again.
- You have the ability to switch back to the patient orthogonal orientation. This means that the MPR segments remain in the true orthogonal orientations (axial, sagittal, coronal view) as you scroll along the path.
- You can label paths and measurements on the **Measurement** list.

Simply click on a selected entry and re-name it, as you would do in normal Windows applications.

- To improve the visibility of paths, the translucent mode is automatically switched on after segmentation. You can switch the **translucent** mode on and off via the right mouse button menu.
- You can modify the course of a path in the Volume or the MPR Segment by using the **Edit** entry in the context sensitive menu (right mouse button).
- With the manual mode, all path points have to be set by you.

– Position path points at the beginning of a vessel, wherever the vessel changes its course and at the end of the vessel.
– Position the individual path points in the most suitable image segment (Volume or MPR segment).
– For the identification of branched vessels, also position a path point where the branches join.

Depending on the number as well as accuracy used in positioning the path points, the paths represent the actual course of the blood vessels.

Manual mode does not isolate the vessel tree from the surrounding tissue and bones. For this purpose, the Tube Mode may be used.

- The Tube is a clipping tool, which creates a cylindrical volume following the center line of the selected vessel. The radius of the tube can be changed by you.

The Tube provides a quick way to either keep the tube volume (= the volume around the vessel) and remove the surrounding structures, or to remove the tube volume and keep the surrounding structures.

Usually this only makes sense after a manual path creation, because the segmentation does a more precise job in separating vessel from surrounding tissue.

- Use the menu option **File > Save Session** to save intermediate results of a Vessel View session. Restore the session by first loading the patient images to **Vessel View** and then selecting **File > Load Session**.

Do not delete the series **VVIEW_NONIMAGE_SERIES** until you have fully completed the evaluation of your patient. This series contains non-image data which is required by the **Load Session** function to restore a previously interrupted session.

- After completion of a recording, the AVI files will automatically be stored in a directory set by the system, e.g. H:\SiteData\VesselView\Movies.

You can review the movies by opening the **File Browser** via main menu entry **Options > File Browser**.

With an external PC connected you can access your offline data on the external PC for postprocessing.

- Select the desired files and double-click on them.
- The corresponding program, e.g. Windows Media Player will be opened and you can review what you have saved.
- Now you can send these files to floppy or burn them on to CD.

***syngo* Argus** is a dedicated software for Cardiac Functional Analysis and 4D Visualization.

Key Features

- Support evaluation with CT and MR data sets
- Cine preview of Ventricular Wall Motion with the time-serial images
- Manual and Automatic Detection of Cardiac Borders
- Software guided evaluation procedure
- Quantification of Cardiac Function:
  - Ventricular Volumes
  - Myocardial Mass
  - Hemodynamic Parameters such as Ejection Fraction, Stroke Volume, Cardiac Output
  - Left Ventricle Wall Thickening Analysis

Prerequisites

***syngo* Argus** analysis is performed with MPR images created from a Coronary CTA acquisition with Retrospective ECG gating. This makes use of all the information available in the Coronary CTA data for the entire cardiac cycle – a one-stop shop imaging technique for both cardiac morphology and function.

The MPR images may be oriented parallel to the long, short or neutral axis of the heart. A neutral-axis will generally correspond to one of the 3 orthogonal patient axes: axial, sagittal or coronal.

Automated contour detection is only possible with short-axis images, which are used in most instances.

In order to compute all cardiac functional parameters, volume curves and dynamic thickening information, sufficient slice levels to cover the heart and time frames to cover the cardiac cycle must be available. For partial quantitative evaluation, only images from the End Diastole and End Systole are required.

Scanning and Reconstruction

If you want to use short axis images of the heart there are different possibilities to create them:

During scanning

You can reconstruct short axis spiral oblique (SPO) images in different heart phases directly during the examination.

After scanning

1. If you have saved the raw data of the Cardio scan: You can reconstruct short axis spiral oblique (SPO) images in different heart phases by loading the raw data in the **Examination** card of your Navigator, or you can also load the raw data in the **Recon** card of your Wizard (optional) console.
2. After reconstruction of different axial heart phases, you can reconstruct short axis MPR images on the **3D** card.

Hint

Do not enter any comments on the 2nd comment line which is reserved for labeling of the cardiac phase and heart rate in beats per minute (bpm).

Scan Protocols

There are three protocols which have seven recon jobs predefined. Five of these recon jobs are oblique 3D reconstructions for special heartviews.

Additionally there are three protocols which have four recon jobs predefined. Two of these recon job are oblique multiphase reconstruction for creating movies and load them into the **InSpace4D** application.

SOMATOM Sensation 64:

- CoronaryCTARoutine033s
- CoronaryCTARoutine037s
- CoronaryCTAVol037s
- CoronaryCTAVol033s

SOMATOM Sensation 40:

- CoronaryCTARoutine037s
- CoronaryCTAVol037s

SOMATOM Emotion 6:

- CoronaryCTARoutine06s

For example for SOMATOM Sensation 64 and the scan protocol CoronaryCTAVol033s seven recon jobs are predefined:

1. axial 3 mm slice,
   3 mm increment for filming or archiving
2. axial 0.6 mm slice, increment 0.4 mm for MIPs
3. RAO
   3D Reconstruction for the best LM/LAD view with a Heart phase of 55% (recommended heart rate 60 bpm).
   Image Type MIP is used.
4. LAO
   3D Reconstruction for the best RCA view with a Heart phase of 55% (recommended heart rate 60 bpm).
   Image Type MIP is used.
5. CX
   3D Reconstruction for the best LM/LAD/CX view (SpiderView) with a Heart phase of 55% (recommended heart rate 60 bpm).
   Image Type MIP is used.

6. ShortAxis
   3D Reconstruction for the best view on the short heart axis
   Multiphase reconstruction of heart phase from 10 to 100%, interval = 10% for ***syngo* Argus**.
   Image Type MPR is used.
7. EjectionFraction
   3D Reconstruction for the best view on the short heart axis
   Multiphase reconstruction of heart phase 20% (systolic) and 80% (diastolic) for ***syngo* Argus**.
   Image Type MPR is used.

Short Axis

*Short axis reconstruction on the **Examination** or **Recon** card:*

Select
– **Recon axis – oblique**
– **Image type – MPR**
– **Enable Button – FreeMode**

FreeMode:
- *Off: You can navigate through the volume by moving the reference lines.*
  The FoV does not move.
- *On: The reference lines can be rotated to obtain oblique/double-oblique views.*

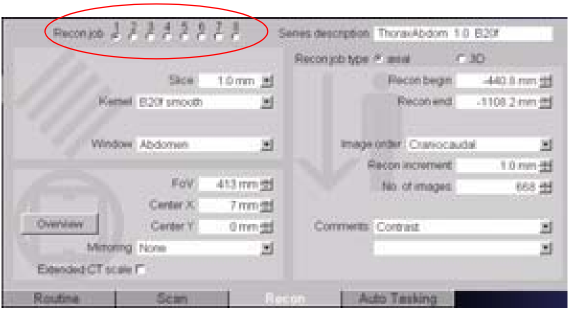
Select the coronal view, rotate the sagittal line to the level of the heart valve and the sulcus.

Distance between Images = 8 mm

Slice Thickness = 8 mm

Multiphase Reconstruction

Select a new recon job on the **Recon** card:



Select the **Multiphase** button on the **Trigger** tabcard.

With a right mouse click on the **Multiphase** button you can open the **HeartView Configuration** window.

Three different **Multiphase settings** are possible

1. **Protocol**
   displays the settings for the selected scan protocol.
2. **Auto**
   You can define the heart phase settings with a regular interval in between, e.g. for an Argus movie.
3. **Manual**
   You can define the irregular heart phase settings with an interval, e.g. to calculate the Ejection fraction.

All choices are available for % or ms.

Reconstruction Examples

1. *Reconstruction of the whole cardiac cycle, e.g. to create a movie in ARGUS:*

Select Multiphase settings: **Auto** and choose % values.

Enter "10" as **Start** and "100" as **Stop**.
Select "10" as **Interval**.
As result you will get 10 series with the heart phases: **10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%**.

2. *Reconstruction of irregular heart phases, e.g. for the Ejection fraction:*

Select Multiphase settings: **Manual** and choose % values.

Enter "20" for the reconstruction of the **ES** (**minimum** left ventricular lumen) and "80" for the reconstruction of the **ED** (**maximum** left ventricular lumen).

As result you will get 2 series with the heart phases: **20% and 80%**

3. *Reconstruction of irregular heart phases, e.g. for the best display of the coronary arteries:*

***LAO*:**
Select Multiphase settings: **Manual** and choose % values.

Enter "50" "52" "55" "58" "60" to find out the best display of the LAO view.

As result you will get 5 series with the heart phases: **50%, 52%, 55%, 58%, 60%**.

If you want to create your own Multiphase recon job in a cardio scan protocol:

Define either an auto or a manual setting, than select the **Multiphase settings – Protocol**. Press button **Apply**, close the window with **OK**. Then you can save the scan protocol as usual and the selected recon job will be always reconstructed using a multiphase.

Hints

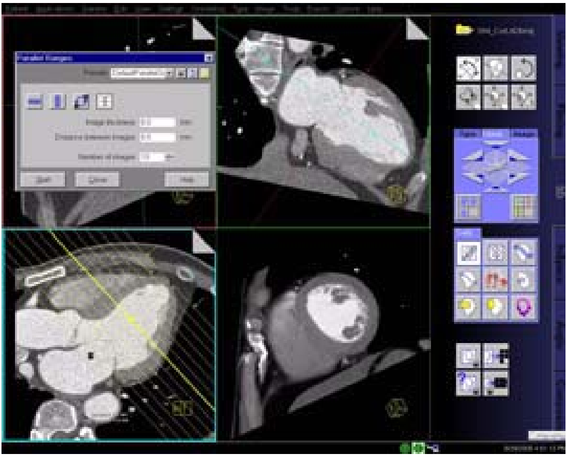
- To get a constant Image quality for the Multiphase reconstruction we recommend turning ECG pulsing **OFF**.
- If you are not sure which heart phases are the best one for the Multiphase reconstruction, perform preview series before.
- Press the **Recon** button for each 3D reconstruction.

Post-processing on the 3D Card

Short-axis MPR images of the Heart

- Load the first (ED) series into **3D** card
- Adjust the reference plane to obtain short-axis views of the heart
- Press the button for **parallel ranges**

Recommended parameters:
Image thickness: 8 mm
Distance between images: 8 mm
Number of images: ~13 (adjust to cover ventricles)



- You must save this MPR range as a preset (Short-axis) for subsequent reformatting of other time series.
- You may link one preset to the series description. In turn the preset will be applied automatically when the next series is loaded into **MPR Ranges**.
- Save the MPR series with a sensible description such as Short Axis, 25%.
- Repeat the procedure with the next series.

Hint

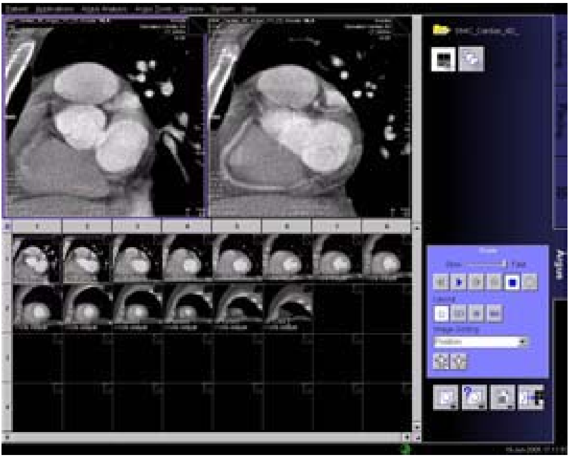
Do not change any parameters for the MPR ranges, otherwise Argus is not able to sort the images correctly.

Workflow

1. Image Loading

- Select all short axis series in the Patient Browser and click on the **Argus** button or use the main menu entry. The series will be loaded to Argus.

2. Argus Viewer



Layout of the Argus card after image loading

- Selection of rows or columns
- You can select entire rows and columns by their controls. Also "Shift" and "Ctrl" works for selection.
- Each Matrix element contains a complete series, indicated by dog ears.

You have the ability to sort the images by two different criteria:

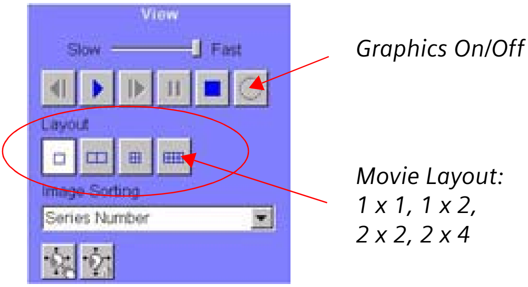
Sort by **Series Number**, each cell with dog-ear corresponds to one series number (One Heart phase).

Sort by **Position**, each cell with dog-ear corresponds to one slice position.

Movie:

- To create a movie of the pumping heart, load all short axis images of the whole cardiac cycle (10 – 100%) into the Argus Viewer.
- Select a slice of the interesting part of the heart and load it into the first segment.
- Change the layout and start the movie.

Movie Controls



You can save the movie via the main menu entry **ArgusTools/MovieControl/SaveMovie as AVI**.

The movie is saved:

➩ On the Wizard: **H:\Site\Data\Argus\Movie**

➩ On the LEONARDO: **E:\Site\Data\Argus\Movie**

On an external PC with a shared folder, you can open the movie by double-clicking on it. The movie will then be displayed using the "Windows Media Player".

3. Argus Evaluation

- Select the Evaluation Mode – Ventricular Analysis.

Layout of "Ventricular Analysis"

- **Image display**

The image matrix is now displayed without dog-ears.

Image sorting:

– into rows by slice position with increasing cardiac phase (in%)

– into columns by cardiac phase (heart phase "xx%") (see comment in image text).

- **Cardiac Border Definition**

Automatically:

1. **ED** and **ES** phase are automatically identified and displayed in the corresponding column heading.
2. **Apex** and **Base** of each phase are automatically indicated by arrows.
3. If you are satisfied with these settings, press button **Accept ED/ES**.

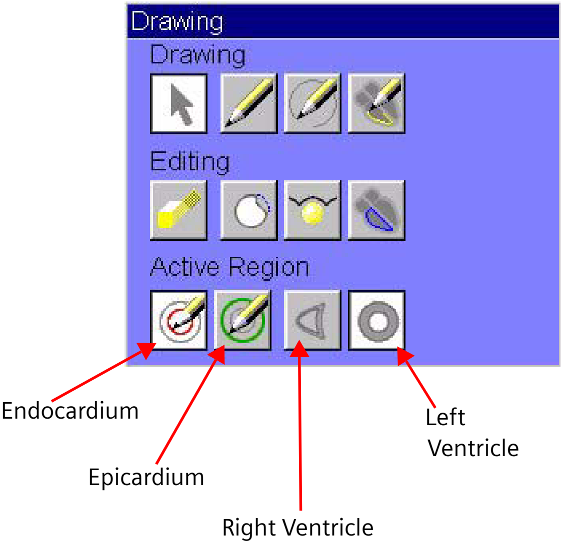
Manually:

1. Check if the automatic selection of **ED**, **ES**, **Base** and **Apex** is correct.
2. If you are not satisfied Drag&Drop **ED** and/or **ES** column heading to the column of your choice.
3. Positions of **Base** and **Apex** will be maintained, indicated by arrows.
4. If you are not satisfied Drag&Drop **Base** and **Apex** indicator (Arrow) to the image of your choice.

The **base slice** icon cannot be moved below the **apical slice** icon and vice versa. It can be moved only in the corresponding phase column.

5. If you are satisfied with these settings, press button **Accept ED/ES**.

4. Contour Drawing

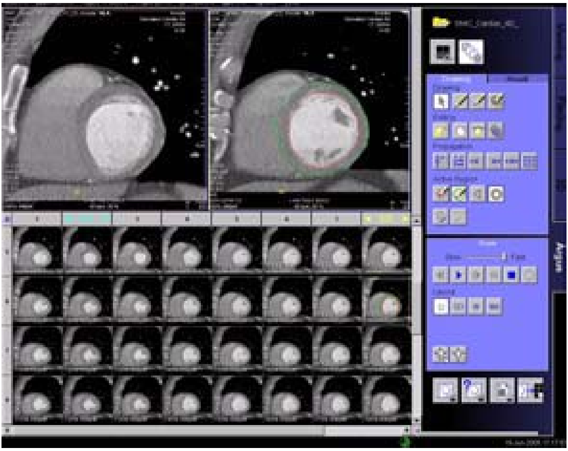


a) Select an ED image in the middle of the heart, use the freehand drawing tool to draw the endocardial contour manually. Double-click to close the contour line, the drawing tools will switch automatically to **epicardial**.

b) Draw the epicardial contour. Double-click to close the contour line.

c) Check the **ED** contours, if necessary use the **nudge** and/or **splice** tool to make adjustments.

d) Press one of the propagation buttons to propagate your drawn contours to all images of the same phase or any other phase.



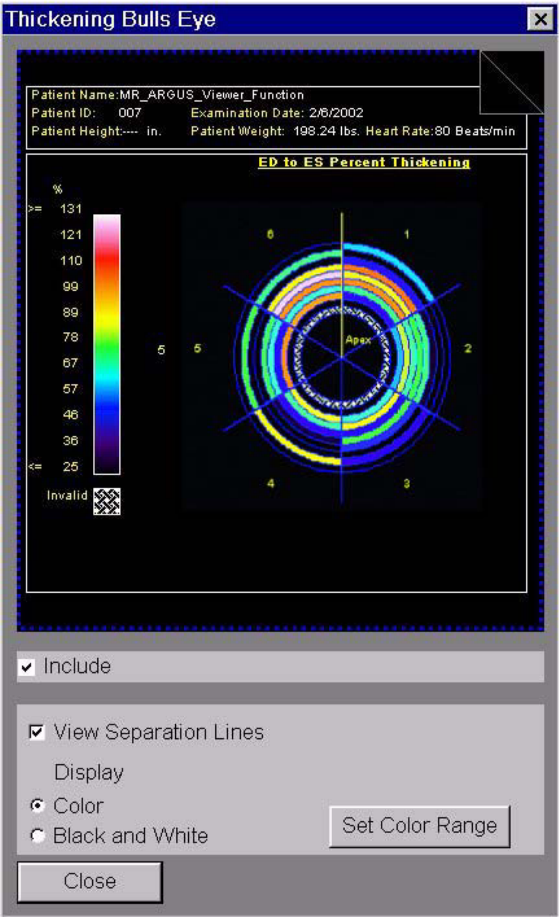
5. Generation of Cardiac Function Results

Ventricular Volume Results

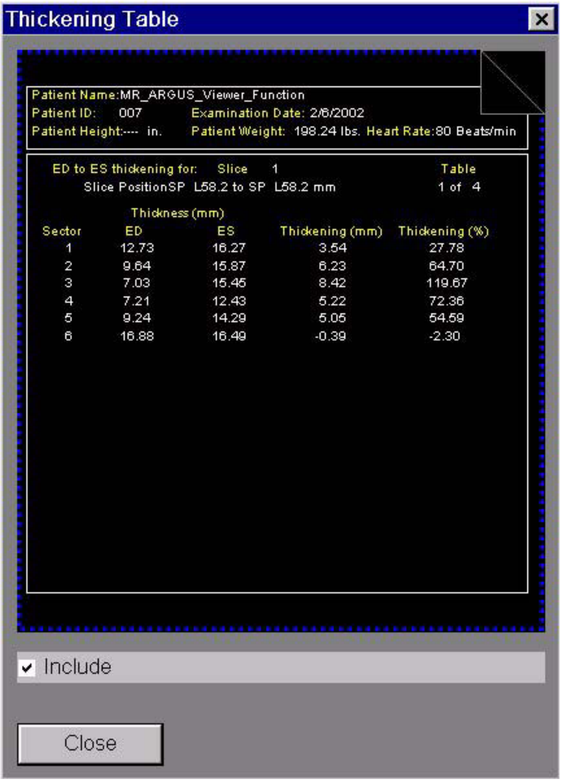
a) Proceed to the **Result** tabcard.
b) Click **Display Volume Results**.
c) Enter values for mean RR interval during examination, patient height and weight. These values are used to calculate normalized values in respect to body surface.
d) Click **Save** to save the results. All images, including the contoured images and the result tables will be saved.

Wall Thickening Analysis

1. Proceed to the **Result** tabcard.
2. Click **Thickening**. The images are now divided into several sectors. If necessary, adjust the number of sectors and define the reference sector.
3. Propagate the sector definition to other images.
4. Press **Display** to show the result tables.
5. Click **Save** to save the images with the thickening sectors and the thickening result tables.
6. Two types of result display are possible.
7. Figure "Thickening Bulls Eye" is an example of a polar plot output of 3D ventricular thickening results. Each ring of the plot corresponds to a different short axis slice level. The central ring represents the most apical slice and the outer ring represents the most basal slice. Each section of the plot corresponds to a sector location as depicted in the sectored images. The color scale of each section of the plot is coded with the parameter value at that wall location. If the analysis is only performed for a slice level, the color plot of the various sectors will be superimposed onto the image itself.



Thickening Bulls Eye



Thickening Result Tables

Hints in General

- MPR series for Argus Ventricular Function analysis should not contain overview images. It is recommended, to deselect **Include the reference image when storing the range** in the 3D configuration.
- When series for Argus VF contain overview images, it can happen that these images are sorted before the ED/ES labeled images in the Argus splash matrix. When computing the volume results then, Argus will issue a warning "**Volumes can not be computed for non parallel slices. Not all results are available**". The results of the analysis are not affected.
- ***syngo* Argus** uses a special image text configuration which can not be changed by you and which can not be filmed.
- In reformatted images (MPR), Argus shows a slice position in the image text. This slice position is given in the patient coordinate system (PCS) as defined by DICOM. The PCS slice position begins always with a letter (**A**: anterior, **P**: posterior, **F**: feet, **H**: head, **R**: right, **L**: left) followed by the coordinate e.g. H 332.5.
- If original axial CT images are loaded, Argus shows both definitions, the PCS slice position and the CT slice position. Argus uses the PCS slice position in its messages.

- The Argus result table also shows normal ranges. The range values are based on the study, Normal human right and left ventricular mass, systolic function, and gender differences by cine magnetic resonance imaging. (see: Lorenz CH, Walker ES et al, J Cardiovasc Magn Reson. 1999;1(1):7 – 21). This study was performed on a group of 75 healthy, predominantly Caucasian subjects.
- If original axial CT images are loaded, Argus shows both definitions, the **PCS slice position** and the **CT slice position**. Argus uses the PCS slice position in its messages.
- ***syngo* Argus** requires CT MPR images reconstructed with any version from VA70 up to now. CT images from other vendors, or CT images that have been reconstructed with older versions do not contain the cardiac phase in their DICOM parameter set. In this case Argus will try to read the cardiac phase from the image comment line. Therefore the image comment line has to be modified manually.
- The format of the image comment line must be "XXXX, ZZZ %" if the phase is specified in % of RR interval "XXXX, ZZZ ms" if the phase is specified in milliseconds.
- XXXX is alphanumeric text of arbitrary length without comma signs, ZZZ denotes the value.

Example 1: this is just a text, 80%
Example 2: 60 Bpm, 233 ms

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