

Clinical Options

syngo Argus

syngo Colonography

syngo Fly Through

syngo InSpace

syngo LungCARE

syngo Vessel View

Software Version A47/A70

SIEMENS

medical

Dear SOMATOM user,
we would like to present you our application guide for clinical options. To improve future versions of this application guide we would highly appreciate your questions, suggestions, and comments.

The information presented in this application guide is for illustration only and is not intended to be relied upon by the reader for instruction as to the practice of medicine.

Any health care practitioner reading this information is reminded that they must use their own learning, training, and expertise in dealing with their individual patients. This material does not substitute for that duty and is not intended by Siemens Medical Solutions Inc., to be used for any purpose in that regard.

The drugs and doses mentioned herein were specified to the best of our knowledge. We assume no responsibility whatsoever for the accuracy of this information. Variations may prove necessary for individual patients. The treating physician bears the sole responsibility for all of the parameters selected.

The pertaining operating instructions must always be strictly followed when operating a SOMATOM scanner. The statutory source for the technical data are the corresponding data sheets. We express our sincere gratitude to the many customers who contributed valuable input.

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Matrix

	<i>syngo</i> Argus	<i>syngo</i> Colonography
SOMATOM Esprit	–	–
SOMATOM Esprit+	–	–
SOMATOM Balance	–	–
SOMATOM Emotion	–	–
SOMATOM Emotion Duo	–	●
SOMATOM Emotion6	●	●
SOMATOM Volume Access	–	●
SOMATOM Volume Zoom	●	●
SOMATOM Sensation 4	●	●
SOMATOM Sensation 10	●	●
SOMATOM Sensation 16	●	●
SOMATOM Sensation Cardiac	○	●

○ *Standard Option*

● *Option*

– *not available*

depending on the system configuration.

Please contact the local Siemens representative for further information.

<i>syngo</i> Fly Through	<i>syngo</i> InSpace	<i>syngo</i> LungCARE	<i>syngo</i> Vessel View
●	–	–	–
●	–	–	–
●	–	–	●
●	–	●	●
●	–	●	●
●	●	●	●
●	●	●	●
●	●	●	●
●	●	●	●
●	●	●	●
●	●	●	●
●	●	●	○

syngo Argus

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

Key Features

- Support evaluation with CT and MR datasets
- 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

There are no dedicated CT examination protocols for cardiac functional imaging.

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-shop stop 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.

Suggestions for Scan Protocols

1. SOMATOM Sensation16/Cardiac

Use the CoronaryCTARoutine protocol.

	CorCTA
<i>kV</i>	120
<i>Effective mAs</i>	500
<i>Slice collimation</i>	0.75 mm
<i>Slice width</i>	1.0 mm
<i>Feed/Rotation</i>	2.8 mm
<i>Rotation time</i>	0.42 sec.
<i>Kernel</i>	B30f
<i>Increment</i>	0.5 mm
<i>Image order</i>	cr-ca
<i>CTDI_{Vol}</i>	42.0 mGy
<i>Effective dose</i>	Male: 8.4 mSv Female: 12.3 mSv

2. SOMATOM Sensation 10

Use the CoronaryCTA protocol.

	CorCTA
<i>kV</i>	120
<i>Effective mAs</i>	500
<i>Slice collimation</i>	0.75 mm
<i>Slice width</i>	1.0 mm
<i>Feed/Rotation</i>	2.0 mm
<i>Rotation time</i>	0.5 sec.
<i>Kernel</i>	B30f
<i>Increment</i>	0.5 mm
<i>Image order</i>	cr-ca
<i>CTDI_{Vol}</i>	42.0 mGy

3. SOMATOM Sensation 4/Volume Zoom

Use the CoronaryStd protocol.

	CorCTA
<i>kV</i>	120
<i>Effective mAs</i>	400
<i>Slice collimation</i>	1.0 mm
<i>Slice width</i>	1.25 mm
<i>Feed/Rotation</i>	1.5 mm
<i>Rotation time</i>	0.5 sec.
<i>Kernel</i>	B30f
<i>Increment</i>	0.8 mm
<i>Image order</i>	cr-ca

4. SOMATOM Emotion 6

Use the Coronary CTA06s protocol.

	CorCTA
<i>kV</i>	130
<i>Effective mAs</i>	280
<i>Slice collimation</i>	1.0 mm
<i>Slice width</i>	1.25 mm
<i>Feed/Rotation</i>	2.4 mm
<i>Rotation time</i>	0.6 sec.
<i>Kernel</i>	B31s
<i>Increment</i>	0.8 mm
<i>Image order</i>	cr-ca
<i>CTDI_{Vol}</i>	37.0 mGy

Image Reconstruction for End Diastolic and End Systolic Series

Configure Heartview test series to cover the whole cardiac cycle.

Recommended settings:

SOMATOM Sensation 4: ~ 10 images, step 10%

SOMATOM Sensation 16: ~ 20 images, step 5%

SOMATOM Volume Access: ~10 images, step 10%

SOMATOM Volume Zoom: ~10 images, step 10%

Start the test 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).

Check the test series images for the maximum Left Ventricular lumen (ED) and the minimum LV ventricular lumen (ES). If ED or ES timing cannot be clearly determined, because there are two adjacent images with the same contraction, take the time-point in between.

Reconstruction of two full axial image series with the time-points for ES and ED determined from the test series.

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).

3D Postprocessing

Short-axis MPR images of the Heart.

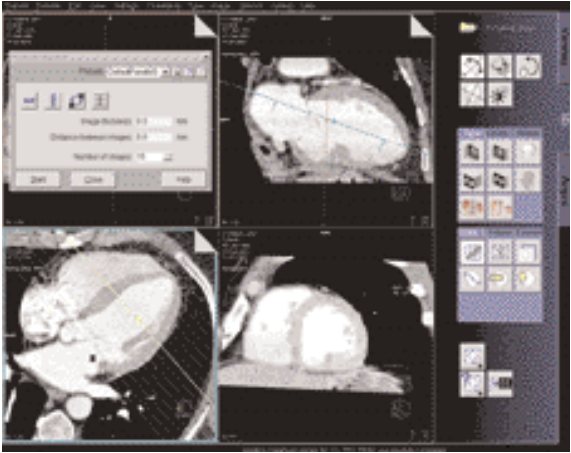
- Load the first (ED) series into 3D Taskcard
- Adjust the reference plane to obtain short-axis views of the heart
- Press button for parallel ranges

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 with other time series.
- You may link one preset to the series description. In this way, the preset will be applied automatically when the next series is loaded.
- Save the MPR series with a sensible description such as Short Axis, 25%.
- Repeat the procedure with the next series.

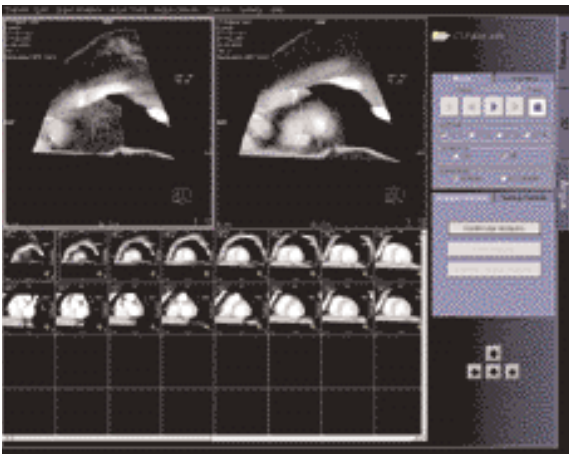
Hint: Do not change any parameters for the MPR ranges. Otherwise Argus is not able to sort the images correctly.

General Workflow

syngo Argus Evaluation

1. Image Viewing

Select all short axis series in the Patient Browser and click on the Argus Button. The images are loaded into an image matrix. The matrix can be used for selection of images to be displayed in the 2 upper working segments.



- Sorting

On the tabcard *Sorting controls* you have the possibility to sort the images.

E. g. Select *Sort by: Image Orientation*
Then by: Slice Position

In this case the images in the matrix are arranged as follows:

- In the rows, you have different heart phases at the same slice level of the heart.
- In the columns, you have different slice levels of the heart at the same heart phase.

- Cine Display
 - To see wall motion at the same position of the heart, select display *Direction in row*.
 - To see the different slice levels of the heart in one particular cardiac phase, select display *Direction in column*.
 - If necessary, use the *cropping* function to zoom up the images.

2. Cardiac Border Definition

- Switch to *Free Mode*.
(Main menu, Argus Analysis, VF Analysis).
In the rows, you have different heart phases at the same slice level of the heart;
In the columns, you have different slice levels of the heart at the same heart phase.

- ED/ES tabcard

Proceed with the *ED/ES tabcard*.

Check if the automatic selection of ED, ES, Base and Apex is correct.

If yes, click *Accept ED/ES settings*.

If not: Click into the ES, Base image.

Use right mouse button to set manually the phase ES,

Use right mouse button to set Base.

Click into the ED Base image.

Use right mouse button to set manually the phase ED,

Use right mouse button to set Base.

Click into the ES, Apex image.

Use right mouse button to set Apex.

Click into the ED Apex image.

Use right mouse button to set Apex.

If necessary use crop/windowing for magnification and windowing.

syngo Argus

- Contour tabcard

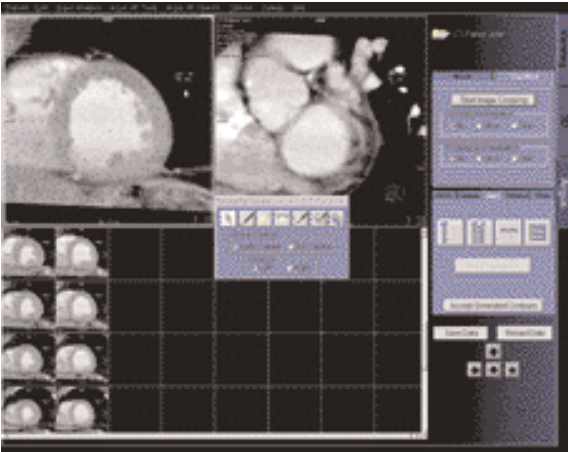
Proceed with the *Contour tabcard*.

- 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".
- Draw the epicardial contour.

- Auto tabcard

Proceed with the *Auto tabcard*, press the ED button for automatic propagation within ED.

- Check the ED contours, if necessary use the nudge tool to make adjustments.



- Press Button ED/ES to propagate the contours to ES phase.
- If necessary do adjustments.
- Click *accept generated contours* to confirm that all contours are anatomically correct.

Generation of Cardiac Function Results

- Ventricular Volume Results

- Volume tabcard.

Proceed to the *Volume tabcard*.

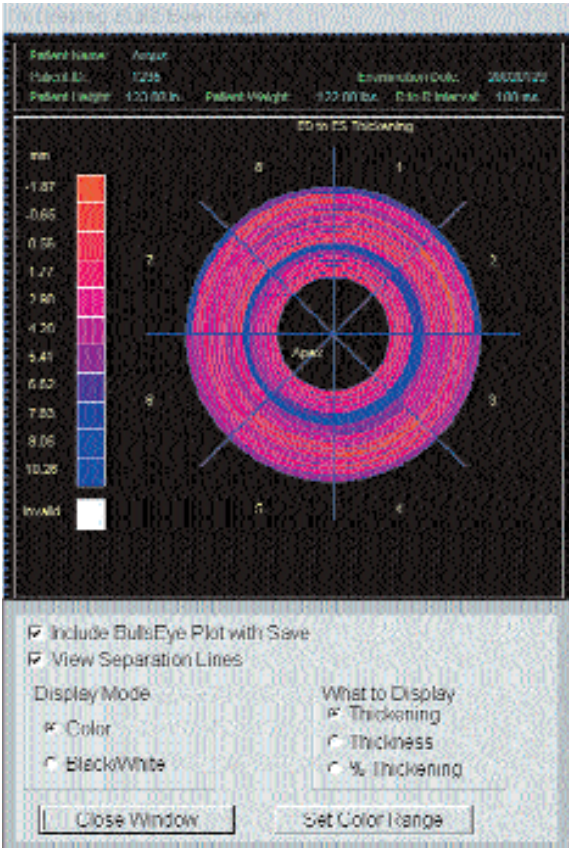
- Enter values for mean RR interval during examination, patient height and weight. These values are used to calculate normalized values in respect to body surface.
- Click display volume results.
- Click *Save Data* to save the results. The contoured images and the result tables will be saved.

- Wall Thickening Analysis

- Thick tabcard

Proceed to the *Thick tabcard*.

- The images are now divided into several sectors.
- If necessary adjust the number of sectors and define the reference sector.
- Propagate the sector definition to other images.
- Press *Display* to show the result tables.
- Press *Save Data* to save the images with the thickening sectors and the thickening result tables.
- Two types of result display is possible:
 - 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

Patient Name: Argus		Examination Date: 20020129	
Patient ID: 1225		Patient Weight: 122.00 lbs. RfoRInteract: 100 res.	
Patient Height: 123.00 in.			

ED to ES thickening for: Slice 1			Table
From Slice Position SP: 438.7 to SP: 439.7 mm			1 of 16
Section	ES Thickness (mm)	Thickening (mm)	% Thickening (%)
1	15.08	6.28	52.17
2	15.16	7.79	107.00
3	8.38	4.38	60.16
4	8.38	4.83	112.32
5	11.38	4.08	72.81
6	13.68	4.43	47.81
7	12.14	7.14	74.18
8	13.87	5.87	44.15

Include all Tables with Saws

Page 1 of 16

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 the user 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.

- syngo Argus requires CT MPR images reconstructed with Somaris VA40 or VA50. CT images from other vendors, or CT images that have been reconstructed with older versions of Somaris 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.

Example1: this is just a text, 80%

Example2: 60 Bpm, 233 ms

syngo Colonography

This is a promising application, dedicated to visualize and evaluate lesions in the colon. This study is not only non-invasive, but a much more comfortable method for the patient.

Key Features

- Very small lesions can be visualized
- Loading of two datasets for comparison
- After loading the images, the evaluation starts automatically at the rectum position
- Lesion detection in MPRs and virtual endoscopy
- Switching between single and side by side view
- Automatic endoscopic navigation
- Fly back offers a view from the opposite side
- Recording of a movie at any time
- Easy and flexible reporting of the evaluated lesions

Prerequisites

1. A comprehensive study consists of four sections:
Preparation, examination in supine & prone positioning, and postprocessing.

- Patient preparation

Important for good results in a *syngo* Colonography evaluation adequate preparation in bowel cleaning must be done. The patient has to start with a diet and bowel cleansing two days prior to the examination like for a conventional Colonoscopy.

- Patient examination

The bowel can be delineated with air, or, if desired, with carbon dioxide. Inflate the colon to the patients maximum tolerance.

To decrease colon spasm, e. g. Buscopan™ or Glucagon™ can be given IV.

Usually, a prone and supine examination is done to differentiate between polyps and stool within the colon. The second scan can be performed with lower dose, e. g. 30 to 50 mAs.

For your *syngo* Colonography evaluation, you can use one or two series of the same study or different studies of the same patient. The images must fulfill the following conditions:

- Only load original, axial CT images of the same patient acquired without gantry tilt.

Suggestions for Scan Protocol

Use the Colonography protocol. We recommend using a tube voltage of at least 120 kV.

Use the images of the second reconstruction for the colon evaluation.

1. SOMATOM Sensation 16/Cardiac

	Colonography	2 nd reconstr.
kV	120	
Effective mAs	100	
Slice collimation	0.75 mm	
Slice width	5.0 mm	1.0 mm
Feed/Rotation	18.0 mm	
Rotation time	0.5 sec.	
Kernel	B30f	B30f
Increment	5.0 mm	0.7 mm
Image order	cr-ca	
CTDI _{Vol}	7.8 mGy	
Effective dose	Male: 4.5 mSv Female: 7.7 mSv	

2. SOMATOM Sensation 10

	Colonography	2 nd reconstr.
kV	120	
mAs	100	
Slice collimation	0.75 mm	
Slice width	5.0 mm	1.0 mm
Feed/Rotation	11.2 mm	
Rotation time	0.5 sec.	
Kernel	B30f	B30f
Increment	5 mm	0.7 mm
Image order	cr-ca	
CTDI _{Vol}	8.2 mGy	

3. SOMATOM Sensation 4/Volume Zoom

	Colonography	2 nd reconstr.
kV	120	
mAs	100	
Slice collimation	1.0 mm	
Slice width	5.0 mm	1.25 mm
Feed/Rotation	6.0 mm	
Rotation time	0.5 sec.	
Kernel	B30f	B30f
Increment	5.0 mm	0.7 mm
Image order	cr-ca	

4. SOMATOM Volume Access

	Colonography	2 nd reconstr.
kV	120	
mAs	100	
Slice collimation	2.5 mm	
Slice width	7.0 mm	3.0 mm
Feed/Rotation	10.0 mm	
Rotation time	0.5 sec.	
Kernel	B30f	B30f
Increment	7.0 mm	2.0 mm
Image order	cr-ca	

5. SOMATOM Emotion 6

	Colonography	2 nd reconstr.
kV	130	
mAs	90	
Slice collimation	1.0 mm	
Slice width	5.0 mm	1.25 mm
Feed/Rotation	1.08/9.0 mm	
Rotation time	0.8/0.6 sec.	
Kernel	B41s	B41s
Increment	5.0 mm	0.8 mm
Image order	cr-ca	
CTDI _{Vol}	11.9 mGy	

6. SOMATOM Emotion Duo

	Colonography	2 nd reconstr.
<i>kV</i>	130	
<i>mAs</i>	90	
<i>Slice collimation</i>	2.5 mm	
<i>Slice width</i>	6.0 mm	3.0 mm
<i>Feed/Rotation</i>	10.0 mm	
<i>Rotation time</i>	0.8 sec.	1.0 sec.
<i>Kernel</i>	B40s	B40s
<i>Increment</i>	6.0 mm	2.0 mm
<i>Image order</i>	cr-ca	

General Workflow

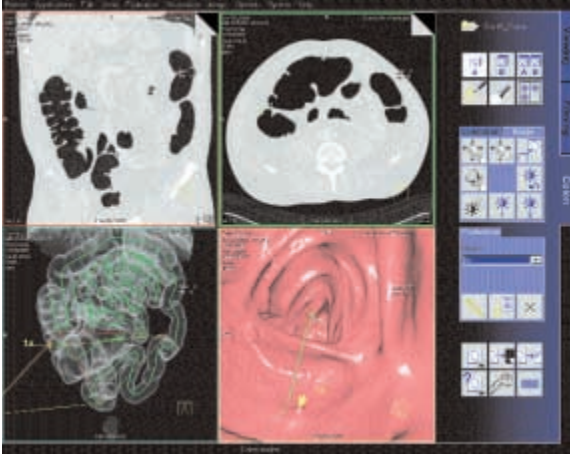
Layout of the Taskcard

After loading the series into *syngo* Colonography a 4-segment layout is displayed.

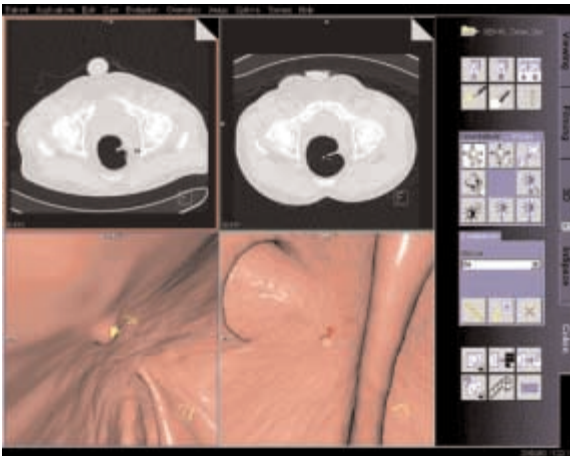
- Upper left segment:
Scroll View using MPR for fast and easy navigation through the colon. As default, a coronal view is displayed. Markers can be set for further evaluation and documentation.
- Upper right segment:
Scroll View using MPR for fast and easy navigation through the colon. As default, a transversal view is displayed. Markers can be set for further evaluation and documentation.
- Lower left segment:
Global View showing a three-dimensional unobscured, overall view of the whole colon in a double-contrast display. This segment provides an overview with markers, the current position of the virtual endoscope and its field of view, and the path traveled in the Endo View Segment.

syngo Colonography

- Lower right segment:
Endo View looks like an original endoscopic view, using perspective SSD (pSSD). With the auto navigation a flight with the virtual endoscope along an automatically calculated path is started.



User interface of syngo Colonography



Supine and prone position in "Side by Side" view.

Visualization and Evaluation

Two workflows are possible:

- a) First identify and mark all the suspected lesions in the entire data set during the first pass navigation. As a second step you can do the individual close-up evaluation of the pre-marked lesions.
- b) Immediately evaluate each suspicious lesion as soon as it is visualized during the first navigation.

Identification and Marking of Lesions

- Load one or two series of the same patient into *syngo* Colonography. The images are always displayed in the same orientation. The system will automatically find the starting point at the lowest position in the rectum.
- Select the desired dataset (A or B) or use the side by side view for comparison.
- Scroll through the dataset with the slabs of the two Scroll Views.
- Set the virtual endoscope to the required start point.
- Fly with the virtual endoscope forward and backward through the volume to identify lesions. The Global view provides an overview of the current position and the path traveled.
- Set lesion markers in the Endo View or in the Scroll View segments. The markers always get the extension of the corresponding dataset, e. g. 1a.
- Set a bookmark to save all segments with all parameters, i. e., position, zoom/pan, orientation temporarily.

Close-up Inspection of Lesions

- Turn the virtual endoscope to look exactly at the lesion of interest.
- Activate Fly Around and rotate the volume displayed around the centered marker to view the lesion from all sides.
- Fly backward to get a view on the lesion from the opposite direction.
- Change to Side by Side View to differentiate between polyps and fecal matter.
- Switch between endo and combined mode to display the surrounding tissue.

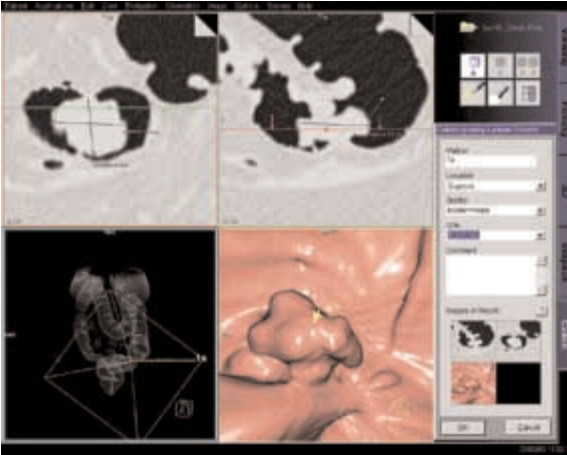
Measurements of Lesions

- Select a marker from the marker list, all segments will be updated to the position of the marker.
- Select a Scroll View segment where the lesion is best visible.
- Activate Blow-up mode.
- Click on the Distance button on the Evaluation subtask card and draw a distance line.

Documentation and Reporting

- In the Endo View Segment, you can record a movie of your virtual flight through the colon at any time.
- As soon as distance lines are measured, they are documented in the Colonography Lesion Details dialog. You can add comments to each entry.
- You can include up to four images for each lesion in your report. Select the image you require and copy it to the report. The copied image is also saved in the local database.
- During the evaluation, specific details such as the location, quality, and size of each lesion can be entered into the Colonography lesion details dialog.

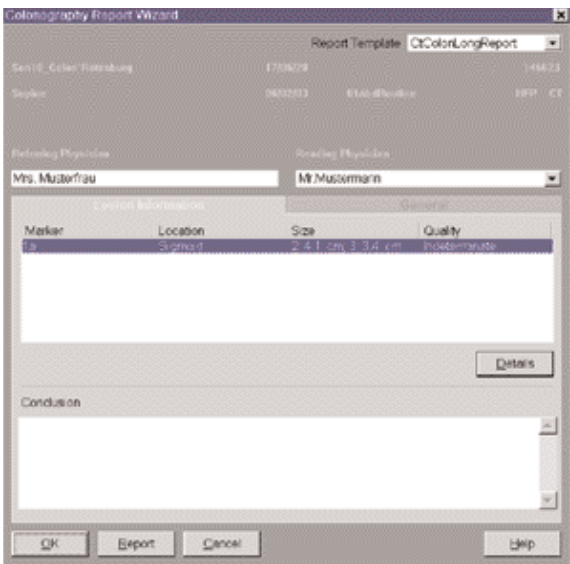
syngo Colonography



The *Report Wizard* provides a brief table of the evaluated lesions.

The user can enter any additional observed abnormalities and the conclusion as well.

- The Report template is configurable.
- It is possible to print the report or to export the report in several formats, e. g. PDF-, HTML- or RTF-Format.



syngo Fly Through

syngo Fly Through is a Virtual CT Endoscopy Software integrated into the syngo 3D functionality. It offers the possibility to render endoluminal views of structures such as the airways, vessels and colons from volume data sets where real endoscopic procedures are not possible.

Virtual CT Endoscopy simulates diagnostic conventional endoscopic procedures e. g. bronchoscopy and colonoscopy, that are usually uncomfortable and more invasive to the patient.

Key Features

- Add-on advanced 3D functionality (Fly icon) integrated in the existing, familiar 3D taskcard.
- One-click access to perspective endoscopic rendering at a point of interest.
- Both Shaded Surface Display (SSD) and Volume Rendering Technique (VRT) can be used.
- Volume Rendering Technique* (VRT) presets can be stored in the VRT* gallery and linked to specific examination protocol or series description.
- Endoscopic viewing parameters e. g. the viewing angle, depth and the viewing distance from the endoscope can be defined and linked to a data set.
- Manual or Automatic endoscopic navigation.
- Fly path planning creates and saves a flight path in the volume data set. This offers the possibilities to play back a endoscopic evaluation and to create a series of an endoscopic snapshots that can be saved on the database.

* syngo VRT is an option on the 3D Card

Prerequisites

This software works with CT, MR and conventional Angiographic data sets.

CTA data set with good vessel enhancement for virtual angioscopy.

Volume data set acquired with overlapping thin-slice CT technique through the lungs or contrast-filled colon.

The Basics for CT Virtual Endoscopy

SSD and VRT* Presets for Endoscopic Renderings

In order to create endoluminal displays with CT data set, we need to differentiate the structures of interest from the rest of the anatomy. This can be achieved with either positive or negative contrast enhancement.

In principle, there are few objects/media which are suitable for endoscopic renderings:

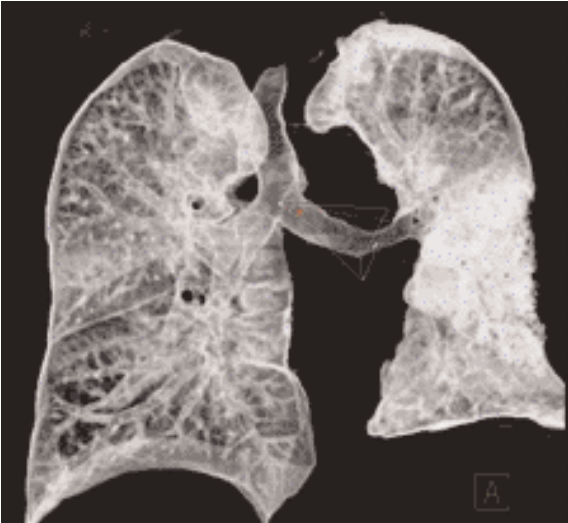
- Gas, e. g. air or carbon dioxide
- Fluid, e. g. water, Iodine-based intravenous/infusion media or Barium-based oral and rectal contrast agents
- Bone
- Metal, e. g. stents

* syngo VRT is an option on the 3D Card

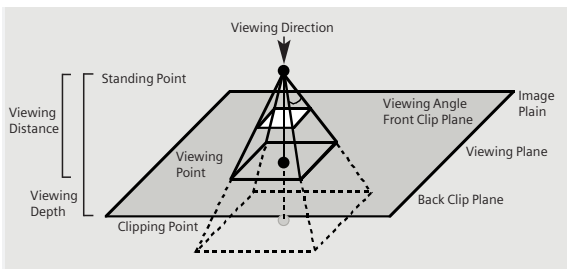
syngo Fly Through

Endoscopic Viewing Parameters/Fly Cone Settings

In general, the shape of a pyramidal cone can be used to represent visualization of an endoscopic volume. The boundaries and the viewing perspective of the endoscopic volume are defined by adjusting the shape and size of this cone.



Cone setting for flying through the airways.



Cone Graphic and Definition

syngo Fly Through

- Standing Point
 - The cone rotates around the viewing point.
- Viewing Point
 - The complete cone moves.
- Clipping Point
 - The cone rotates around the standing point.
- Viewing Angle
 - Is changed by moving one of the sides of the angle.
- Viewing Distance
 - The distance from the Standing- to the Viewing Point.
- Viewing Depth
 - Moving the Front/Back Clip Plane changes the viewing depth.
- Front Clip Plane
 - To remove foreground-obscuring tissue.
The position of the front clip plane will always be between standing and viewing point.
- Back Clip Plane
 - To remove tissue at the back of the volume.
The position of the back clip plane will always be behind viewing point.

Patient Preparation

Bony and cartilaginous structures such as the central airway and bronchial tree, the osteomeatal system of the Paranasal Sinuses are inherently filled with air and therefore ideal for performing Virtual CT Endoscopy. No special preparations are required.

For CT endoscopic evaluation of the vessel (virtual CT angiography), a good CTA data set with good vessel enhancement is required.

In the case of CT colonography, adequate preparation in bowel cleaning must be done prior to the CT exam. The bowel can be delineated with air, carbon dioxide, water or iodine/barium suspension.

General Workflow

Load the images in 3D.

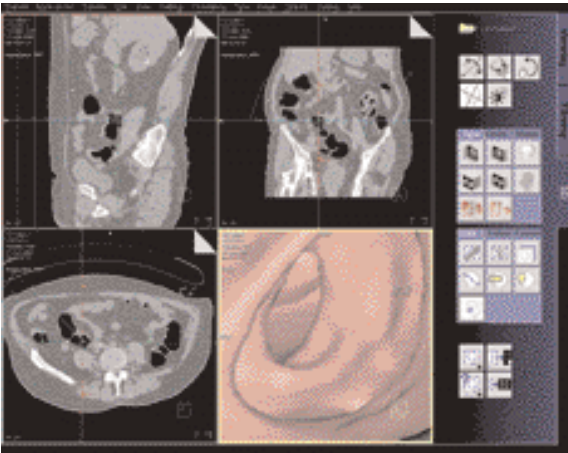
The following standard layout is displayed:

Segment 1: Sagittal view

Segment 2: Coronal view

Segment 3: Transversal view

Segment 4: Fly segment with perspective SSD as default



Scroll through the MPR images until you reach an image where you would like to start the CT endoscopic evaluation.

syngo Fly Through

Position the Reference lines at that point of interest e. g. in the rectum for CT Colonography.

Click the Fly Through icon to activate the endoscopic display in Segment 4.

The default endoscopic display has the same orientation (viewing direction) as the last selected image segment in which you placed the point of interest and invoked the *syngo* Fly Through option.

Change the endoscopic display by adjusting the SSD threshold or change to VRT* display.

Link the new settings to data set for future application. Define the Cone settings (endoscopic viewing parameters) and link the cone settings to data set for future application.

Start the endoscopic navigation by using:

- Manual method
- Auto-navigation
- Path creation

Create flight path through the data set and save the path for future playback.

Click the "Save Image" button before navigating the endoscopic projection along the path.

A series of endoscopic snapshots will be created and saved automatically on the database.

These images can be documented on hardcopy or loaded to Viewer for cine display of the endoscopic movie.

* *syngo* VRT is an option on the 3D Card

Navigation of the Endoscopic Volume

- Manual Navigation

Click with the right mouse button in the Fly segment to activate the SmartSelect menu.

The following controls are available:

- auto-navigation
- push/pull
- rotate around viewing point
- rotate view

Adjust the viewing direction and select push/pull.

Click and hold with the left mouse button.

Move the mouse up or down to navigate through the endoscopic volume manually.

- Auto Navigation

Adjust the initial viewing direction.

Activate the SmartSelect menu

Select the function auto-navigation.

Click and hold with the left mouse button. Give the mouse a small upward push and then hold it steady.

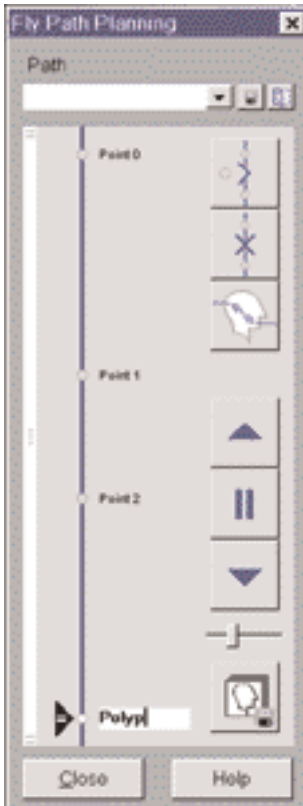
The software will automatically detect the centerline and navigate through the endoscopic volume without any user intervention.

To stop or change the direction of the navigation, release the mouse and adjust the viewing direction accordingly before proceeding further.

syngo Fly Through

Fly Path Planning

Open the Fly Path Planning.



Create a path by inserting path points in the volume during navigation.

The relevant settings (viewing direction, viewing angle etc.) are stored along the path.

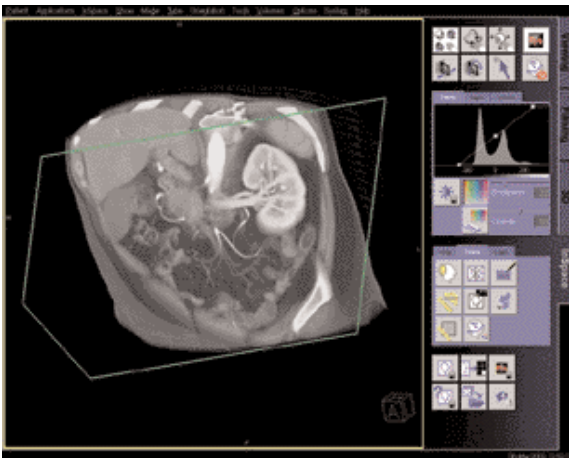
After defining and storing a path it is possible to play back the entire navigation along the path as a movie or to jump straight to the section of the endoscopic volume predefined by the path points.

Note: Only one path can be saved with each data set. To define another flight path through the same volume, the existing path will be overwritten and deleted.

InSpace

syngo InSpace is an interactive volume viewer tailored for modern volume scanners.

InSpace is the real-time volume rendering application of syngo offering the very highest image quality and interactive performance even with your largest datasets. The primary focus of InSpace is to melt very rapidly through a complete 3D image volume using a clip plane or image slab to reveal the desired anatomy. This is analogous to 2D-cine mode, but much faster, and with freely-controllable double-oblique orientation within the whole 3D volume.



Key Features

- Genuinely real-time 3D
- VRT, MIP, MinIP, MPR
- Clip plane and image slab melt-through
- Very high IQ
- Support for very large volumes
- 3D measurements
- Documentation, including AVI digital movies

Basics

InSpace provides two different working modes:

Expert or Beginner mode. You can select and change more parameters in Expert mode.

This mode is recommended for experienced users only.

You can use the optional VolumePro Graphics accelerator card to provide exceptional image quality and provide support for very large volumes at maximum interactive performance. The InSpace/Settings/Quality menu allows you to activate and deactivate VolumePro mode (only available in Expert mode).



Prerequisites

Loading of Images

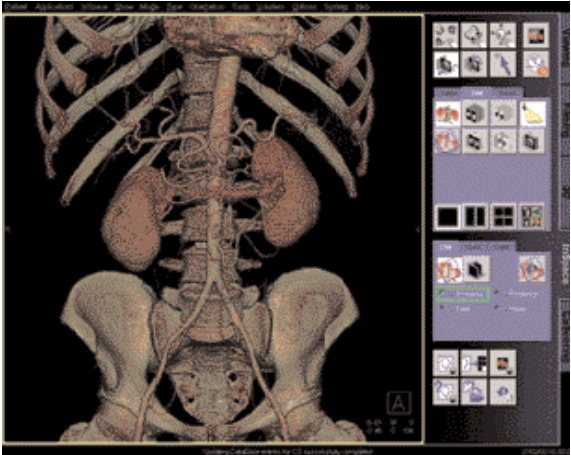
- Only load CT and MR images.
- You can load three data sets.
Recommended: Load no more than two data sets at the same time.
- You should close any data sets that you no longer need in order to release memory space and maintain application performance.
- CT volume data sets are best acquired with overlapping thin-slice CT technique.

If the data you have selected contain several volumes for display, the Study Purifier dialog box opens. You have the option to:

- Select a single data set, or
- Merge two or more data sets to form a volume, or
- Display two or more data sets as separate volumes.



Layout of Screen



The image area is used for 3D VRT, MIP, MinIP or MPR image display in one, two or four segments. Whenever you change image parameters, the modifications are displayed in real time.

The taskcard control area has four regions:

- Mode buttons

The six mouse mode buttons on the left are used for image control. The two buttons on the right are used for High Quality and Hide All Graphics.

- Upper stack of subtask cards

These subtask cards are used to set tissue classification, rendering mode, screen layout, and orientation.

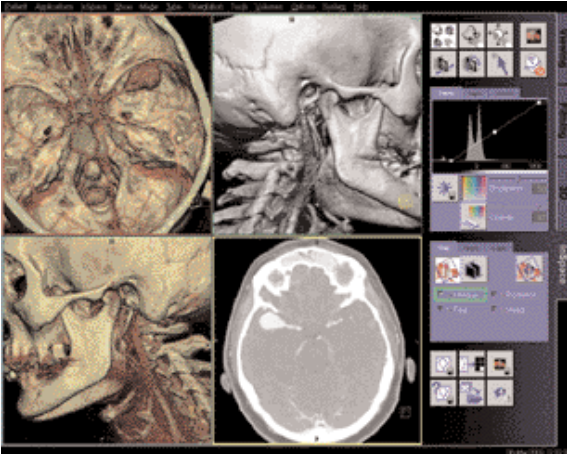
- Lower stack of subtask cards

Contains the settings for clip planes, tools, and advanced lighting. The Advanced Lighting function is only available with the optional VolumePro graphics accelerator.

- Input/output buttons

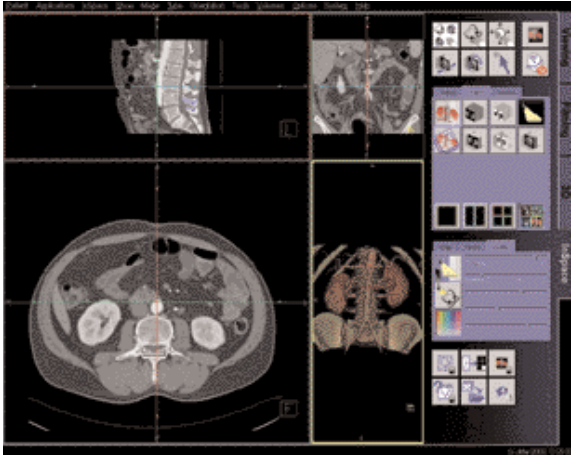
These buttons are used to save or film result images, and to close the current series.

- Image segment area layouts
 - Four different layouts of the image area are provided:
 - Single View Mode
 - Two View Mode
 - Four View Mode
 - MPR View Mode



The layout can be modified:

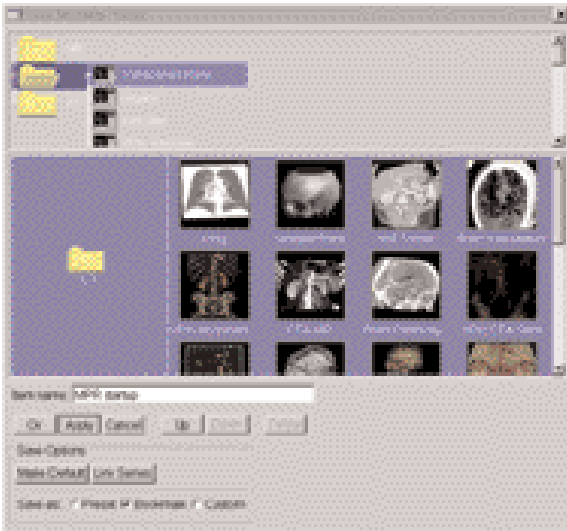
- Blow-up any segment to full-screen, or blow-down by left-mouse double-click.
- Drag segment boundaries or intersection in 2- or 4-view layouts.
- Reset layout by clicking again on the depressed layout icon.



Startup Configuration

A default startup layout can be configured, or the startup layout can be linked to a series description so that the layout is applied automatically for all such series:

- To make a Default startup bookmark create the screen layout and image settings that you need, then in InSpace/Save Modality Preset:
 - check the “Bookmark” box,
 - press “Make Default”,
 - press “OK”, or,
- To make a startup bookmark that is linked with a specific **Series Description**, load a relevant series, create the screen layout and image settings that you need, then in InSpace/Save Modality Preset:
 - check the “Bookmark” box,
 - press “Link Series”,
 - press “OK”.
- To activate the autolayout mechanism select “Yes” or “Ask me” In InSpace/Settings/Bookmarks – Auto Configuration Loading.



General Workflow

In general, *syngo* InSpace display, evaluation and documentation tools can be used in any workflow sequence. For an interactive 3D diagnosis using double-oblique “3D melt-through” a typical workflow would involve the following steps:

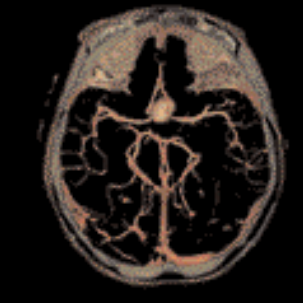
- Load series into a (default) MPR layout
- To view axial dataset, scroll through the axial MPR segment using LMB push-pull (double-click segment if you want it full screen).
Tip: press the “Quality” button to ensure maximum image quality.
- Select 1 x 1 layout to show the 3D View.
Tip: release Quality button for maximum interactive performance.
- To evaluate soft tissue, select VRT rendering mode, or a soft tissue preset, and add a single clip-plane. Adjust window settings using MMB, and also the “opacity” if necessary. Adjust clip-plane position and orientation to “melt through” and reveal desired anatomy.

- To evaluate vessels, select a MIP preset and add a pair of clip planes using “Slab Mode”, or simply select “slab-MIP” rendering. Adjust window settings as needed using MMB. Adjust slab position, thickness and orientation to see only the required vessels.
- Manipulate the volume by pan, zoom and rotation using mouse mode icons at top of task-card.
- At any time during the interaction you may use tools to make annotated measurements, edit the data, and document to film sheet, disk-file image such as JPEG or AVI digital movie in MPEG4 format.

Extended Workflow Techniques

Other techniques that you may find useful, some of which are available only in “Expert” mode, include: Volume manipulation, windowing, presets

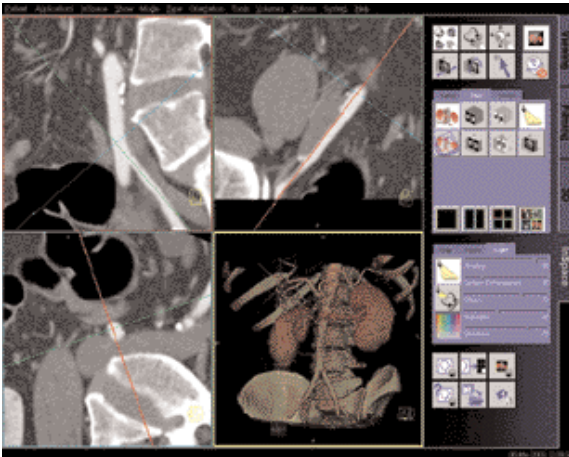
- Use modality presets to select different rendering settings, including color VRT.
- Ramp and trapezoid manipulation: Ramps and trapezoids are functions which define window and rendering settings. Trapezoids can also be used to delimit a tissue classification range (e. g. bone in a CT image).
- Change rendering settings using the table classifier trapezoids. Moving the ramp changes the window width and center. Opacity and brightness can be adjusted to optimize organ-specific settings. With the RMB options related to ramps and trapezoids are available.
- Lighting to enhance 3D. The lighting direction arrow is used to define the direction of incident light.
- As well as the individual mouse mode icons, all volume and clip-plane manipulation can be accomplished without mode change using the “manipulate all objects” icon.
- In this mode, Pan and Zoom can be performed even when a clip-plane is present by using the MMB while pressing the Shift key.



MPR Mode

- Double oblique MPR

The MPR View Mode divides the image area into three orthogonal reference images with the 3D view in the fourth segment. Adjust the reference line center position and orientation to create double-oblique views.



Editing the Volume

- Cropping

This editing method is to crop the entire volume (box edit). Cropping limits you to three orthogonal directions.

- VOI punching
ROIs can be used to remove more complex shapes from the volume. ROIs can be drawn around the wanted (Keep inside) or around the unwanted (keep outside) region. Drawing several ROIs before punching saves time.
- Clip planes
Clip planes can also be used for hiding parts of the dataset. The number of clip planes available depends on the selected mode:
 - Beginner mode: one
 - Expert mode with VolumePro: four
 - Expert mode without VolumePro: six

Measurement and Evaluation

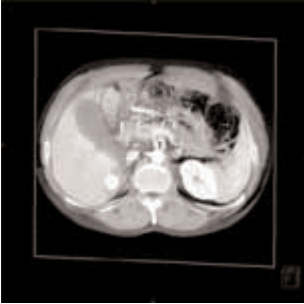
- We recommend performing measurements on MPR planes. For 2D measurements, always use clip planes oriented parallel to the screen.
- Measure by placing a grid over the image, and moving its center and orientation as required.
- Measure distances and angles using the measurement feature on the Tools subtask card.

Documentation to Film and Database

- Images can be documented to the virtual film sheet, or a Postscript printer.
- Images can be saved to the DICOM patient database, or can be exported to disk file in JPEG, BMP, TIF, PNG formats.
- Digital movies
You can generate digital movies, using various compressed AVI formats, such as MPEG 4. You can then replay movies on other computers or send them from there via the Internet or Intranet, to discuss findings with other specialists, for example.
- Output ranges
The Ranges function provides a simple way of creating a radial range series from 3D images. You can then send these series to the screen, output them on film or as a movie, or store them to the patient database.

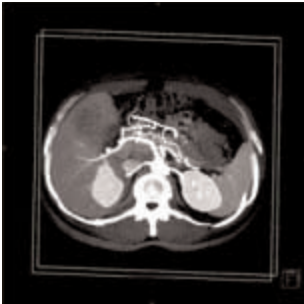
Case Examples

Soft Tissue Evaluation using clipped VRT



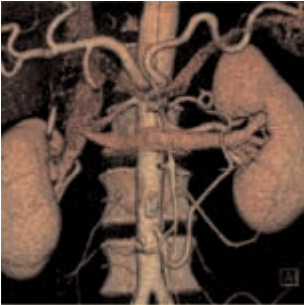
1. Load series
2. Select soft tissue preset, adjust windowing as needed.
3. Enable a single clip-plane.
4. Manipulate volume to evaluate anatomy:
 - a) Orientate the clip-plane and image volume for the best view of the anatomy.
 - b) Push-pull the clip plane through the volume.
 - c) Adjust window and opacity as necessary.
 - d) Pan and zoom image as necessary.
 - e) To eliminate unwanted bone either activate clip planes or use VOI punching.
5. Measure, annotate and document as needed.

Examination of Vascular Trees, using Slab MIP



1. Load series.
2. Select slab-MIP rendering.
3. Select MIP preset, or adjust window.
4. Manipulate volume to evaluate anatomy:
 - a) Orientate the slab and image volume for the best view of the anatomy.
 - b) Push-pull the slab through the volume.
 - c) Adjust window and opacity as necessary.
 - d) Pan and zoom image as necessary.
 - e) To eliminate unwanted bone either activate clip planes or use VOI punching.
5. Measure, annotate and document as needed.
6. Optionally, create image series using radial ranges and output them either on film, database, or as digital movie.

Vessel Analysis Using Color VRT



1. Load series.
2. Select color VRT preset.
3. Manipulate volume to evaluate anatomy:
 - a) Orientate the image volume for the best view of the anatomy.
 - b) Use clip planes to hide unwanted anatomy.
 - c) Adjust window, opacity, color and lighting effects as necessary.
 - d) Pan and zoom image as necessary.
 - e) To eliminate unwanted bone either activate clip planes or use VOI punching.
4. Use lighting for optimum 3D display (in VolumePro mode only).
5. Either select a default preset that has lighting or define your own lighting effects and set the incident light direction (usually from the front).
 - a) Lighting options and recommendations:
 - b) Shading: 80
 - c) Surface Enhancement: 20
 - d) Diffuse: 70
 - e) Highlights: 80
 - f) Shininess: 20
6. Measure, annotate and document as needed.
7. Optionally, create image series using radial ranges and output them either as a film, database, or digital movie.

You can also perform oblique MPR assessment of vessels as follows:

1. Align a single clip plane so that it cuts the vessel in the same direction as the required MPR.
2. Select Align MPR view from the Orient subtask card.
3. If necessary, also adjust MPR positions and perform measurements.

Examination of the Colon



1. Load series.
2. Select the caudo-cranial view.
3. Select double-contrast colon VRT preset.
4. The table parameters are based on a single trapezoid with the following properties:
 - a) Very narrow trapezoid.
 - b) Trapezoid positioned on the Hounsfield scale in the region of air.
 - c) Reduced opacity (opacity approx. 25).
5. To eliminate surrounding soft tissue punch out VOI. It is important to select a high punch value (around 500).
6. Manipulate volume to evaluate anatomy:
 - a) Orientate the image volume for the best view of the anatomy.
 - b) Adjust window and opacity as necessary.
 - c) Pan and zoom image as necessary.
 - d) Use a clip plane to hide parts of the colon if necessary.
7. Measure, annotate and document as needed.

syngo LungCARE

A dedicated software for visualization and evaluation of pulmonary nodules using low-dose lung scanning and for subsequent follow-up studies.

Key Features

- 3D Visualization with Thin Slabs using MPR, MIP and VRT displays.
- Computer-guided localization of pre-marked lesion.
- Close-up inspection of suspected lesion with the Rotating MPR mode.
- Automatic evaluation of pulmonary nodules with perspective VRT or MPR display.
- Automatic volume and diameter measurements of pulmonary nodules.
- Easy and flexible reporting of the evaluated nodules.
- Follow-up mode with synchronization of two datasets.

Prerequisites

- High Resolution volume data set which was acquired within a single breathhold.
- The data set must be contiguous.
- Nearly Isotropic data volume. Maximal acceptance up to 10 mm slice thickness, but the thinner the slices the better the results.
- Only original images can be used. No postprocessed or compressed images.
- For a better synchronization in Follow-up mode the datasets should cover nearly the same volume.

Suggestions for Scan Protocols

1. SOMATOM Sensation 16/Cardiac

Use the LungCARE protocol.

Sensation 16	LungCARE
<i>kV</i>	120
<i>mAs</i>	20*
<i>Slice collimation</i>	0.75 mm
<i>Slice width</i>	1.0 mm
<i>Feed/Rotation</i>	18.0 mm
<i>Rotation time</i>	0.5 sec.
<i>Kernel</i>	B50f
<i>Increment</i>	0.5 mm
<i>Image order</i>	cr-ca
<i>CTDI_{Vol}</i>	1.6 mGy
<i>Effective dose</i>	Male: 0.6 mSv Female: 0.7 mSv

* 10-40 mAs depending on patient size.

2. SOMATOM Sensation 10

Use the LungCARE protocol.

Sensation 16	LungCARE
<i>kV</i>	120
<i>mAs</i>	20*
<i>Slice collimation</i>	0.75 mm
<i>Slice width</i>	1.0 mm
<i>Feed/Rotation</i>	11.3 mm
<i>Rotation time</i>	0.5 sec.
<i>Kernel</i>	B50f
<i>Increment</i>	0.5 mm
<i>Image order</i>	cr-ca
<i>CTDI_{Vol}</i>	1.6 mGy
<i>Effective dose</i>	Male: 0.6 mSv Female: 0.7 mSv

* 10-40 mAs depending on patient size.

3. SOMATOM Sensation 4/Volume Zoom

	LungCARE
kV	120
mAs	20
Slice collimation	1.0 mm
Slice width	1.25 mm
Feed/Rotation	4.0/5.0 mm*
Rotation time	0.5/0.75 sec.*
Kernel	B50f
Increment	0.7 mm
Image order	ca-cr

* For SOMATOM Sensation 4 with maximum gantry rotation speed of 0.75 s per rotation.

4. SOMATOM Emotion Duo

	LungCARE
kV	110
mAs	18*
Slice collimation	4.0 mm
Slice width	5.0 mm
Feed/Rotation	16.0 mm
Rotation time	0.8/1.0 sec.
Kernel	B50s
Increment	3.0 mm
Image order	ca-cr

* 18-60 mAs depending on patient size.

5. SOMATOM Volume Access

	LungCARE
kV	120
mAs	15*
Slice collimation	2.5 mm
Slice width	3.0 mm
Feed/Rotation	10.0 mm
Rotation time	0.5 sec.
Kernel	B50f
Increment	2.0 mm
Image order	ca-cr

* 15-60 mAs depending on patient size.

6. SOMATOM Emotion 6

	LungCARE
kV	110
mAs	15*
Slice collimation	1.0 mm
Slice width	6.0 mm
Feed/Rotation	10.8 mm
Rotation time	0.8/0.6 sec.
Kernel	B50s
Increment	0.8 mm
Image order	cr-ca
CTDI _{Vol}	1.36 mGy

* 15-60 mAs depending on patient size.

7. SOMATOM Emotion

	LungCARE
kV	110
mAs	36*
Slice collimation	5.0 mm
Feed/Rotation	5.0 mm
Rotation time	0.8/1.0 sec.
Kernel	B50s
Increment	5.0 mm
Image order	ca-cr

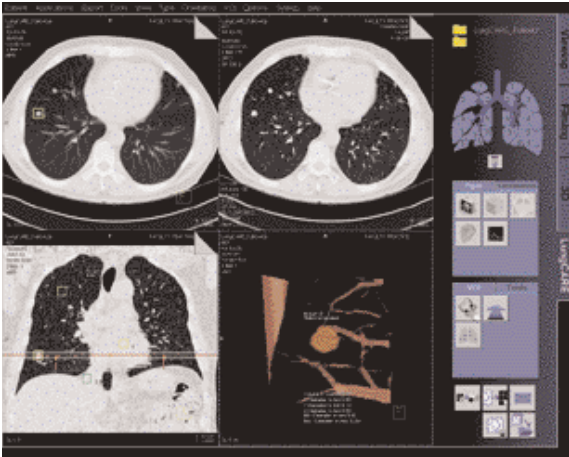
* 36-60 mAs depending on patient size.

General Workflow

Taskcard Layout

After loading a series into *syngo* LungCARE a 4-segments layout is displayed.

- upper left segment: Interactive Slab Segment
- upper right segment: Slice Reference Segment
- lower left segment: Slab Reference Segment
- lower right segment: VOI Segment



Interactive Slab Segment

- The upper left segment displays a thick 3D slab of the data volume.
- Allows navigation in a slab with adjustable thickness interactively and in Realtime through the volume.
- Different visualization techniques are available: Thick MPR, Thin MIP, VRT Thick.
- Possibility to change the Orientation of the Slab and to do a blow up into a full screen layout.

Slice Reference Segment

► The upper right segment displays the original axial slices of the data volume.

- Allows navigation through the axial slices of the data volume.
- The best corresponding Slice Reference is displayed.

Slab Reference Segment

► The lower left segment displays a coronal MPR of the loaded data volume.

- In the Slab Reference Segment the location and the thickness of the slab from the Slab Segment is displayed with two bounding lines, they are arranged symmetrically to a middle line. The view direction of the Slab for the slab segment is identified with arrows.
- It is possible to navigate through the MPR in the Slab Reference Segment.
- You can navigate rapidly through the volume by either
 - dragging the slab to any position
 - using the marker as navigator aid.

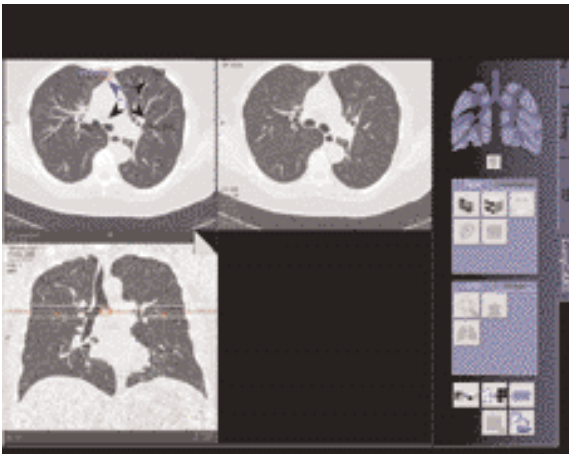
Visualization and Evaluation

Two workflows are possible:

- a) First identify and mark all the suspected lesions in the entire dataset during the first pass navigation. Then do as a second step, the individual close-up evaluation of the pre-marked lesions.
- b) Immediately evaluate each suspicious lesion as soon as it was visualized during the first navigation.

1. Identification and Marking of Lesion

- Load the series into *syngo* LungCARE.
- Scroll through the dataset with Thin-slab MPR, MIP or VRT in the Slab Segment.
- Click on a suspicious lesion, activate the rotating MPR with the SmartSelect menu. Magnified MPR projections rotating along the center which is created by the current mouse position. It is now possible to distinguish between solitary structures (e. g. pulmonary nodule) and elongated structures (e. g. vessel).
- Mark any suspicious lesions by activating the SmartSelect menu.
- The marker is shown in the Slab Segment and in the Slab Reference Segment.
- The best corresponding slice is shown in the Slice Reference Segment.
- As you scroll through the dataset, markers are displayed in the Interactive Slab Segment accordingly.



2. Segmentation of the Nodule and Volume Calculation

- Click on the lung nodule, activate "VOI" with the SmartSelect menu.
- A localized, magnified (perspective rendering) VRT with the lung nodule is displayed in the lower right segment (VOI Segment).
- It is possible to interactively rotate and zoom the Volume of Interest in VRT.
- The VRT display can be changed to MPR, with the possibility to scroll through the volume and to change the orientation to axial, coronal or sagittal.
- With the SmartSelect menu, activate the function "Evaluate Nodule".
- A segmentation of the nodule is started, the segmented nodule is highlighted in magenta color.
- The software automatically calculates the volume, the diameter in all three axes, and the max/min diameters of the nodule.
- It is also possible:
 - to call up a HU histogram of the nodule
 - to change to SSD display. In this mode, the VOI segment is divided in four areas: three standard views and a perspective view.

You can manually alter the results so as to get as exact a representation of the lesion/nodule as possible if you are not satisfied with the results of the automatic segmentation and evaluation.

3. Follow-up Mode

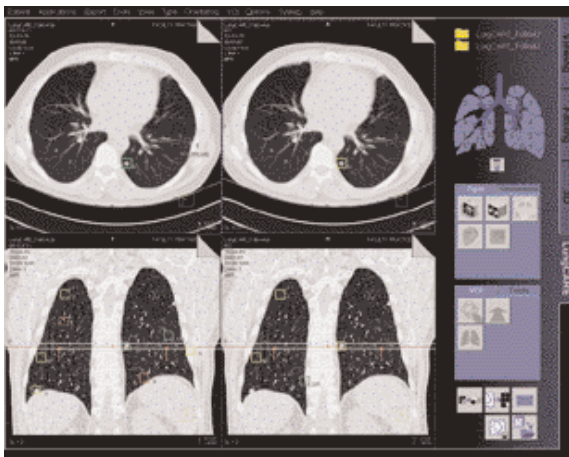
For comparison it is possible to load two datasets into LungCARE. The Layout of the taskcard changes to:

- upper left segment:
Interactive Slab segment of the prestudy
- lower left segment:
Slab Reference segment of the prestudy
- upper right segment:
Interactive Slab segment of the follow-up study
- lower right segment:
Slab Reference segment of follow-up study.

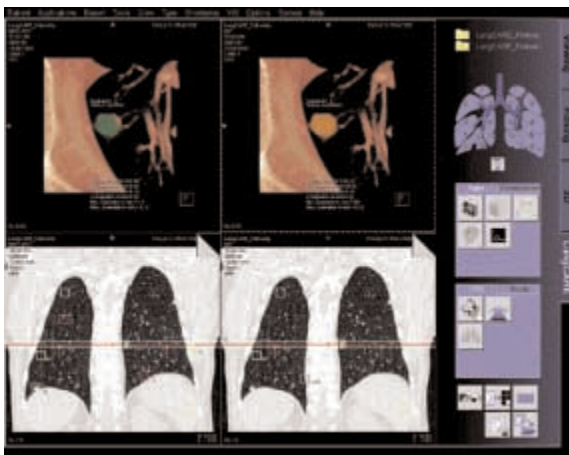
The latest acquisition is always displayed on the right side of the image area. VOI mode is done synchronously for both studies. The Slab segments change to the corresponding VOI segments. You can then continue with the evaluation in the VOI segment of the follow-up study as you are used in single mode.

The Follow-up mode provides:

- Alignment of the slab positions
- Synchronization of viewing parameters, e. g. windowing, zoom/pan
- Get Counterpart:
The same anatomical structure of an evaluated nodule of the prestudy will be found in the follow-up study.
- Linking of counterpart markers:
Linking of two segmented markers transfer the information given in the prestudy automatically to the corresponding nodule of the follow-up study
- Calculation of the growth:
In the report the growth of the nodules will be calculated and clearly illustrated as a history graph.



Display of the Slab segment in FollowUp mode.



Display of the VOI segment in FollowUp mode.

4. Documentation and Report

During the evaluation, specific details such as location, morphology and characteristics of each nodule can be entered into the *Nodule details* dialog.

The entries for the nodule descriptor list boxes can be configured.

Thumbnail of the four segments are automatically displayed in the lower end of the dialog. Up to two of these images can be selected.

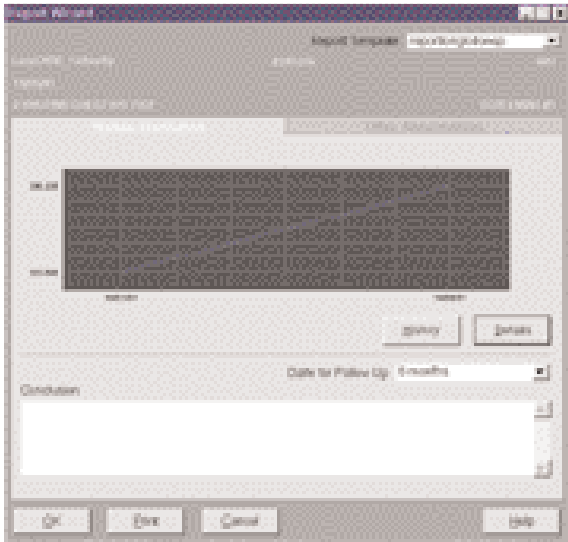


The *Report Wizard* provides the user with a brief table of the evaluated nodules.

The user can enter as well any additional observed abnormalities and his conclusion.

- The Report template is configurable.
- It is possible to print the report or to export the report in several formats e. g. PDF-, HTML- or RTF-Format.
- All information that was manually or automatically entered is saved in the database.

ID	Volume	Location	Max. Diameter	Min. Diameter	Growth
1	1.1 ml	1.1 cm	1.1 cm	0.8 cm	1.1 cm



Display of the history graph in FollowUp mode.

syngo Vessel View

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.
- Protocol guided semi-automatic path planning & auto-segmentation of the vessel.
- 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.
- Setting of Landmarks either along the path, in the Ribbon MPR and in the 3D volume as measurements coordinates.
- Straight & Curved distance measurements.
- Automatic contour detection and area calculation of the vessel lumen orthogonal to the centerline 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.

Prerequisites

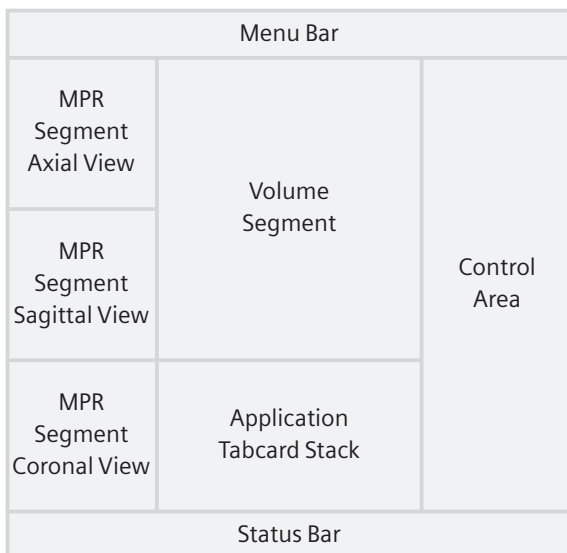
Volume data set with good opacification for vascular analysis, with overlapping thin-slices and a soft kernel reconstruction is recommendable.

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 (optional).

General Workflow

1. Loading the Images

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



MPR Segments

The three small segments on the left are referred as MPR Segments although these segments may also display ThinMIP and ThickMPR. These segments contain manipulator lines, as in the 3D Card, which allow the user 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 taskcard, 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 landmarks. 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. Single click on one side of the cube will set the orientation of the volume to that side.

2. Visualization

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

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

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

- Apply VRT preset from the VRT Gallery.
- Create your own VRT preset.
- Change the W/C setting.
- Freely rotate the volume.
- Click on the Orientation Cube to quickly set the orientation to desired standard views.

Working with the MPR Segments the user may typically

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

To remove unwanted structures the user may

- Punch out unwanted structures.
- Apply clip planes.

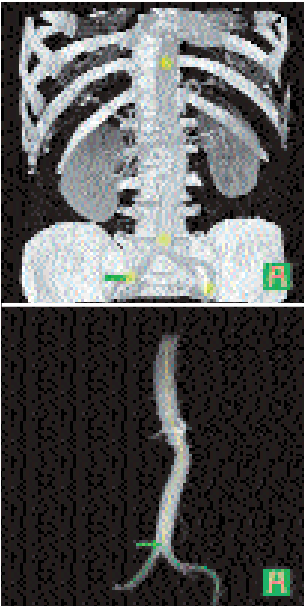
3. Path Creation

In this step, the user places certain points in order to define paths along the centerline of a vessel tree. These paths can be result of a semi- automatic or fully manual segmentation procedure.

a) *Semi-automatic mode*

With the Semi-automatic mode all seed points can be set automatically except the end and branch points.

- Position a seed point at the beginning and end of a path via the left mouse button.
- Position the individual seed points in the most suitable image segment (Volume or MPR segment).
- For the identification of branched vessels, position a seed point where the branches join.



syngo Vessel View

The segmentation algorithm automatically finds the vessel limits and determines the path. If a branched vessel is segmented, a separate path will be created for each branch.

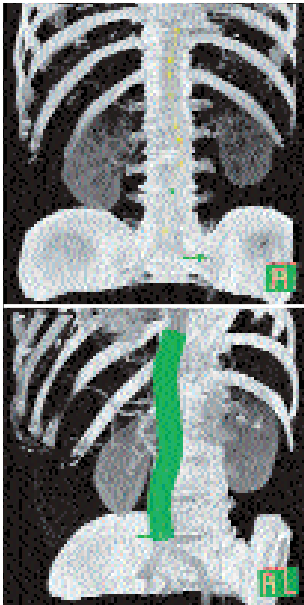
b) Manual mode

With the manual mode all seed points have to be set by the user.

- Position seed points at the beginning of a vessel, wherever the vessel changes course and at the end of the vessel via the left mouse button.
- Position the individual seed points in the most suitable image segment. (Volume or MPR segment).
- For the identification of branched vessels, position a seed 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 path definition has been completed, each path along a vessel branch 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.

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). To improve the visibility of paths reduce the opacity of the Volume Rendering. This can quickly be done by using the Translucent entry in the context sensitive menu.

4. Measurement Analysis

Major objective of the step is to perform measurements. However, finding the appropriate view for the measurement is closely linked to visualization and navigation.

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.

The user has the possibility to switch back to the *Path Orthogonal Orientation*. This means that the MPR Segments remain in the true orthogonal orientations (axial, sagittal, coronal view) as the user scrolls along the path.

To move along a path, the user may

- use the Position Slider
- use the Focus Pointer in the Volume Segment

syngo Vessel View

Landmarks

While moving along a path the user can place Landmarks at diagnostically relevant positions:

- to display these positions again
- to use them for measurements

To set a landmark move the focus pointer to the position where you want to set the landmark and click the landmark button.

There are two types of landmarks:

- Landmarks which are linked to a path
- Free landmarks which can be anywhere in the volume

Tube

Tube is a clipping tool, which creates a cylindrical volume following the centerline of the selected vessel. The radius of the tube can be selected by the user.

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 maintain the surrounding structures.

Fader

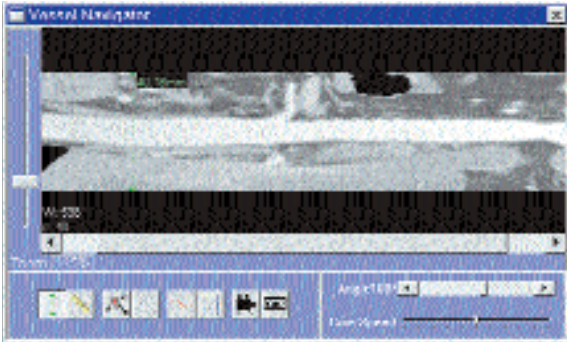
“Removed” parts of the volume are not really deleted from the data set. Instead, they are hidden by the Fader. With the Fader, you may modify the transparency of the “removed” volume.



syngo Vessel View

Vessel Navigator

Once a path exists, the Vessel Navigator can be called up. The Vessel navigator shows a longitudinal cut along the centerline of the vessel, the so-called Ribbon MPR.



- Working with the Vessel Navigator the user may typically
- Change the W/C setting by the middle mouse button.
 - Change the Ribbon Viewer Width (if less than the full vessel width or not enough vessel surroundings are shown).
 - Zoom and Pan to display the region of Interest.
 - Display a curve of the cross-sectional area of the vessel centerline.
 - Measure distances perpendicular to the vessel (e. g. the diameter of a vessel) .
 - Rotate the Ribbon MPR step by step or in cine mode.
 - Measure distances along the vessel centerline by using landmarks.

The Focus Pointer (known from the Volume Segment) is represented by a vertical line. When moving the Focus Pointer, the three MPR Segments are synchronized to the position of the Focus Pointer. The user can position landmarks at the current position of the Focus Pointer.

Performing measurements

The user can

- Measure straight distances in MPR and VRT views.
- Measure the curved path distances between two landmarks.
- Measure axial distances in the Vessel Navigator view.
- Measure areas and diameters by
 - applying the vessel contour at a path point
 - manually drawing a contour in the MPR Segment
 - automatically displaying the curve of the cross-sectional area in the Vessel navigator view
- Measure angles by using three landmarks (one as the apex and one landmark for each leg of the angle).

You can hide measurements and show them again with the menu option Configuration/Show measurements.

Hint: Some functions, e. g. activating the Vessel Navigator or using the Position Slider on the Angio Measurement card, can only work if a path is selected. Select the relevant path on the Angio Path Card if you cannot activate such a function.

5. Documentation of Results

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

Hint: When the Vessel Navigator is up, *Save to Database* and *Copy to Film Sheet* will always take the Ribbon MPR. Close the Vessel Navigator if you want to save any other segment.

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.

Output tables

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. The user can apply the buttons *Save to Database* and *Copy to Filmsheet*.

AVI-File of Vessel Navigator image

The user can generate an avi-file of the Vessel Navigator image rotating around the vessel axis.

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 setting by adjusting the Trapezoids in the definition card.

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

Path Creation

Semi-automatic Mode

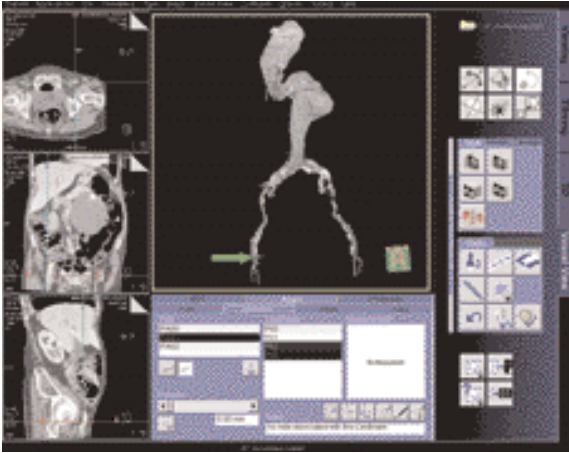
Activate the semi-automatic segmentation mode.

In the Control Area a protocol wizard pops up and guides you through the whole procedure.

Generate centerline paths (in the aorta, left and right iliac arteries) by placing seed-points either on the MPR images or VRT image at the following locations:

- The aorta above renal arteries
- The iliac bifurcation
- The left iliac artery
- The right iliac artery

As soon as the last seed point is inserted, the protocol will perform an automatic segmentation and keep mainly the aortic lumen.



Merging & Editing the Path

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

Depending on the curvature of the aorta, two or more paths may be created.

You can merge the appropriate short paths to form complete paths that run down the aorta to both iliac arteries.

You can also edit the path by repositioning the seed points along the path into the center of the lumen.

Measurements

Select the path of interest.

Using the position slider, you can move the focus pointer and set anatomical landmarks along the path.

The 3 MPRs segments are now displayed orthogonal to the path. These images will be updated as you change the position of the focus marker.

The following measurements can be done:

1. Curved Distance between 2 specific Landmarks points e. g. Origins of the renal arteries to Neck of the Aneurysm.
2. Curved Distance in the central long axis of the Aneurysm by placing landmarks at the upper and lower necks of the Aneurysm.
3. 2D Distance for Maximum Diameter of the Aneurysm and any of the Aortic branches.
4. Automatic contouring and area calculation of the lumen of the Aneurysm and the Aortic branch vessels e. g. iliac arteries.
5. Angle Measurement

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

Visualization

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

Adjust the VRT view by using the VRT Gallery.

You can fine-tune the setting by adjusting the Trapezoids in the definition card.

Use VOI Punch and/or the Clip Planes to remove ribs, spine etc. to isolate the heart.

Change all MPR images into 5 mm thinMIP for better visualization of the coronary arteries.

Path Creation

Use semi-automatic segmentation mode.

Generate a path from the Left Main (LM) and along the Left Anterior Descending Artery (LAD). Set the start point on the LM close to the aorta.

Set the endpoint in the distal LAD.

Hint: If you place the seed points on the axial MPR or thin MIP segments you do not need to isolate the heart in the VRT view.

Measurements

Click on the Vessel Navigator for close-up evaluation of the coronary artery.

A Ribbon/Longitudinal MPR along the path is created.

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 cine mode. Chose a plane that demonstrates the tightest stenosis.

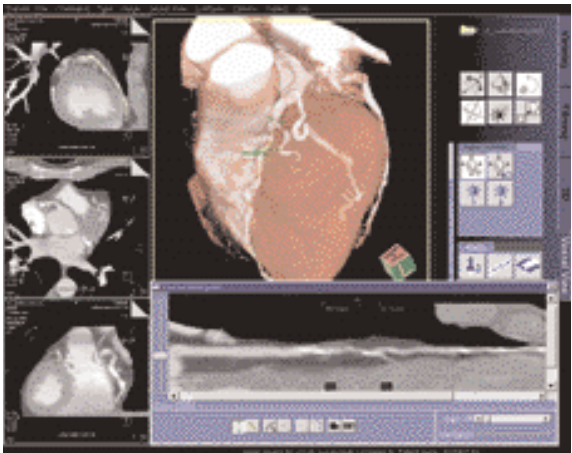
You can move the focus pointer along the vessel by dragging on the green indicator bar in the Vessel Navigator.

syngo Vessel View

The following measurements can be performed:

1. On the Vessel Navigator, vessel diameters at the stenosis, proximal and distal to the stenosis by placing 2D-distance measurements.
2. On the Vessel Navigator, length of the stenosis along the vessel center line by measuring the curved distance between two landmarks immediately proximal and distal to the narrowing.
3. On MPR views, luminal areas at the stenosis (narrowest part of the vessel), before 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.



syngo Vessel View

Workflow for a Carotid Stenosis Case

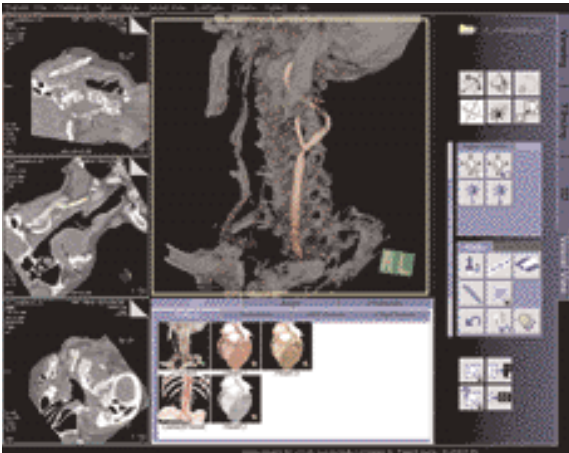
Visualization

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

Adjust the VRT view by using the VRT Gallery. You can fine-tune the setting 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: Hidden 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.



Path Creation

Use Semi-automatic Segmentation Mode

Activate the semi-automatic segmentation mode.

In the Control Area a protocol wizard pops up and guides you through the whole procedure.

Generate centerline paths (in the common, internal and external carotids) by placing seed-points either on the MPR images or VRT image at the following locations:

- the distal part of the common carotids
- the carotid bifurcation
- the internal carotids
- the external carotids

As soon as the last seed point is inserted, the protocol will perform an automatic segmentation and keep mainly the carotid lumen.

Merging & Editing the Path

Following segmentation of the carotids, the resultant paths are shown as a list on the Angio Measurement Card.

Depending on the curvature of the carotids, two or more paths may be created.

You can merge the appropriate short paths to form complete paths that run down the common carotids to both internal and external carotids.

You can also edit the path by repositioning the seed points along the path into the center of the lumen.

Measurements

Click on the Vessel Navigator for close-up evaluation of the carotids.

A Ribbon/Longitudinal MPR along the path is created.

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 cine mode. Chose a plane that demonstrates the tightest stenosis.

You can move the focus pointer along the vessel by dragging on the green indicator bar in the Vessel Navigator.

The following measurements can be performed:

1. Luminal areas at the stenosis (narrowest part of the vessel), before and distal to the stenosis by using the automatic contouring and area calculation functions.
2. Vessel diameters at the stenosis, before and distal to the stenosis by placing 2D-distance measurements along the vessel in the Ribbon MPR.
3. Length of the stenosis by measuring the curved distance between 2 points immediately before and distal to the narrowing.

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